For the Sake of Argument

The Seeing, Not the Seen, Needs Changing

By Norman G. Shidle

"It all depends on how you look at it."

Everybody has said or heard that commonplace phrase . . . heard it so often that triteness obscures its significance. It is backed by the profundities of Hegelian philosophy and by everyday experience in home and office.

Side by side, two people rub sleep from their eyes and squint at a new day. "What gorgeous sunshine," one exclaims. "That light is killing my eyes," the other complains.

Sitting alone in a violent thunderstorm, one man hears the steady ticking of the grandfather clock as marking the moments to impending destruction. Another's spirit is steadied by the clock's calm persistence amid the surrounding cacophony.

One engineer will see people and their reactions as irritating impediments to solution of otherwise simple problems. His associate will see the same people as most normal and interesting parts of the problem itself.

One man the other day commented to a friend: "Practice has convinced me that what goes on in my head is pretty much up to me; that irritations result chiefly from what I permit myself to think *about* something—not primarily from the thing itself."

Another puts it this way: "It is the seeing, not the seen which needs changing."

The main difference between a happy optimist and a worried pessimist is point of view . . . but that is often the difference between victory and defeat, between fear and hope . . . between success and failure.

Almost every minute of the day, we face practical proof that "It all depends on how you look at it."

SAE *Journal*

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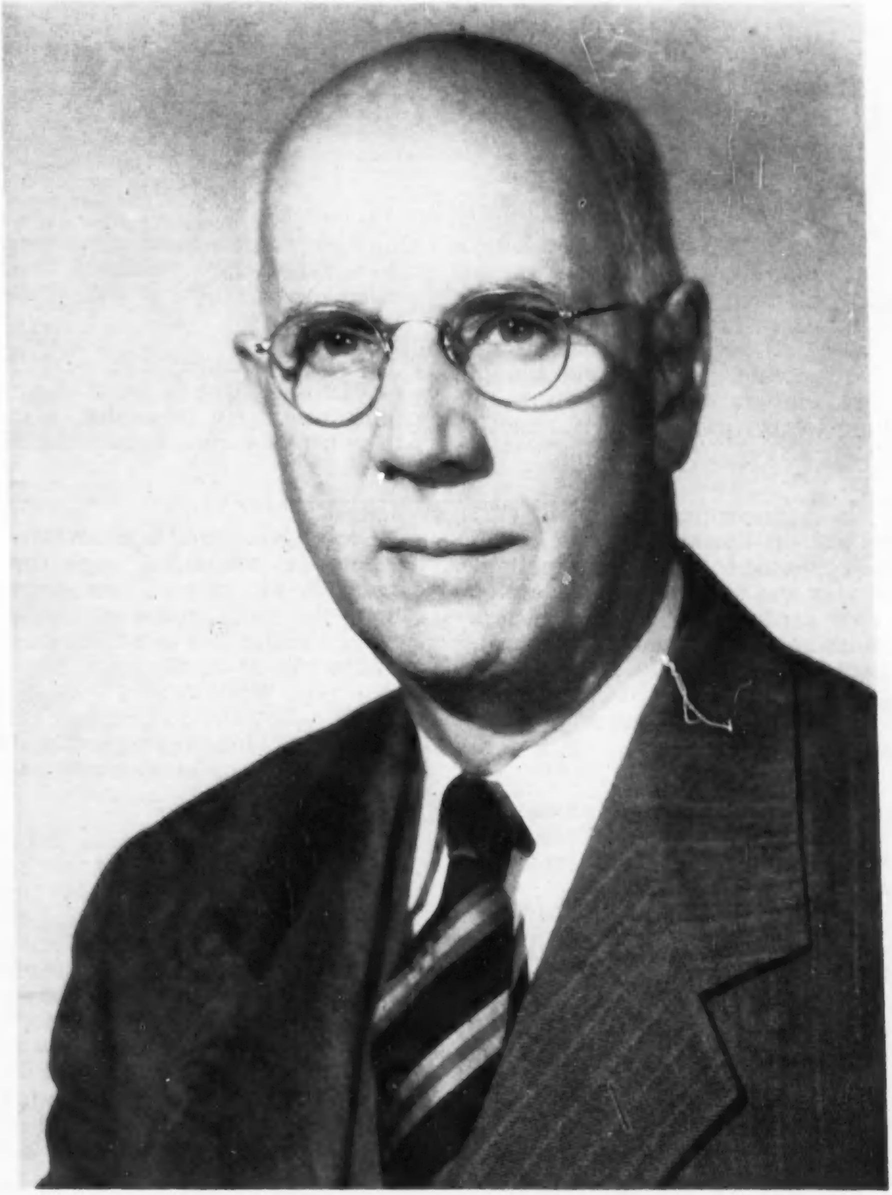
TABLE OF CONTENTS


Bendix Products
CREATIVE ENGINEERING
GEARED TO QUANTITY PRODUCTION
HY AC
ED ABOVE ALL OTHERS!
suggests, however, that Hydrovac* power braking might very profitably be included as original equipment by most manufacturers. If you are interested in taking advantage of this great pre-sold market, write the factory direct for details on Hydrovac—the undisputed leade in power braking.
*REG. U.S. PAT.
BENDIX
DIVISION
SOUTH BEND 20,
BUILDERS
OF THE BASICS
OF BETTER
MOTOR VEHICLES



James E. Hale

1884-1950

JAMES E. HALE, SAE President-elect for 1951 died suddenly of a heart attack at his home in Akron on November 28.

Hale was a man who was happy only when he was creating something. Whether conceiving and developing the first 18.00 × 24 in. earthmover tire or using his own tools to make improvements in his summer home in the Canadian wilds, achieving something useful was his joy in life. The long list of technical advances in which he played a major part indicates he must have lived a happy life.

He was a Firestone man for over 30 years. He rebuilt Firestone's engineering department

back in the early 20's and headed it for a long time. At the time of his death, he was consulting engineer with an interest in the organization's broadest technical problems. But the combination of imagination, initiative, and stick-to-itiveness which was his outstanding characteristic resulted in benefits from his efforts to almost every part of the automotive industry.

Graduated in engineering (BS) from M.I.T., Hale always was on the side of science and engineering as opposed to cut and try methods. This point of view was apparent in his development of proper controls for test fleet operations, of dynamometer equipment for testing functional performance of tires, in pioneering early "balloon" tire developments, and in his contributions to both highway and off-highway tread designs.

While his work on balloon tires for passenger cars received the widest acclaim, he himself considered his contribution to farm tractors of equal importance.

In fact, Hale did some of the creating that so much delighted him in practically every area of tire engineering. He had an active role in every kind of tire for every kind of vehicle developed in the last 35 years . . . and he was never content merely to create and design. He was not one to lay a development on the table, sit back, and let nature take its course. He didn't play golf, but consistently he had a good follow-through. That's one reason the results of his creativeness have found such widespread acceptance and use.

Most dramatic of Hale's later contributions to tire engineering was the huge 18.00×24 in. earthmover tire which resulted in abandonment of duals in favor of the large singles. Many considered these tires definitely in the "it-can't-be-done" category, but experience proved the rightness of Hale's conception.

He was the holder of more than 35 patents, all relating to some phase of tire, rim, or wheel engineering. He presented many technical papers before various organizations, 17 of them to SAE.

He was a consistent and effective participant in technical committee work throughout his career. He was an active, energetic member of each of the many groups with which he served. He had a major role in building up the technical activities of the Tire and Rim Association, in the post-World War I SAE Ordnance Advisory Committee, in the tire phases of the SAE War Engineering Board work in World War II, and many other similar activities.

Hale's mental approach to his hobbies was much the same as to his engineering. He wasn't satisfied just to have his time occupied. He liked to be getting something done. So, on his five-acre home near Akron, he did his own landscaping, planting, and transplanting of flowers and shrubs . . . and at his summer place on Lake Temagami, Ontario, he built and remodeled while his neighbors—if there were any within 10 miles—went fishing. He did like tramping and canoeing, and made many treks through the Temagami wilds and carried many a portage on the way.

Born in Manchester, N. H., on October 13, 1884, Hale entered the tire industry as an experimental engineer at Goodyear Tire & Rubber Co. only a few years after his graduation from M.I.T. in 1908. He joined SAE in 1913, and in 1946 was SAE Vice-President representing Passenger Car Activity.

President's Message . . . .

SAE membership has now reached the impressive total of nearly fifteen thousand. Any group of this size carries some weight, but the SAE is far more than just a large organization.

Consider the fact that its members represent the technology of the greatest manufacturing industry in the world. Consider that the health of our country's economy and the structure of its defense rest on their efforts. Consider that under the banner of the SAE they are united in a great cooperative effort to further progress to these ends through a very active and productive program —and you have the picture of the part which SAE is playing in the national scene.

During the past year, as President, it has been my privilege to observe the inner workings of this organization at close hand. It has been extremely gratifying to me to note the high caliber and quality of the men who are giving so freely of their time to SAE activities. They are men who not only qualify as top grade engineers, but who also hold responsible positions in their companies and are leaders in their community life—who have a desire above and beyond their immediate personal interests to promote the welfare and progress of their profession, their Society, and their country.

To such men of SAE, to all of those who served so faithfully as committee members and workers throughout the Society, and to the members of the permanent staff to whom we are so greatly indebted for the smooth, quiet, effective operation of our Society—my sincerest personal thanks for a job well done.

James C. Zeder

1950 Annual Report

DURING 1950, SAE membership resumed its upward climb, student enrollment went to a new high, and know-how of SAE technical committees once again was called to the service of the military. Publications reflected more fully than in recent years the Society's production of technical material, while meetings set new attendance records. Society reserves rose to $644,000, as expenditures were made of $883,000 and income of $969,000 was taken in.

1950 was a year of progress all along the SAE front.

Membership Curve Resumes Upswing

Overcoming a slight setback in 1949, SAE membership is pushing toward a new high with a total of 14,779 dues-paid members as of September 30, the close of the 1949–1950 fiscal year. The peak for that date was 14,810, attained in 1948. During the past year, 1,664 were added to the membership, as compared with 1,699 the previous twelve months. Membership losses were somewhat less than 1948–1949, decreasing from 1911 to 1483.

A greater number of applications is forecast for the coming year, with indications that a new high in membership may be reached before its close. Both Section and Professional Activity Membership Committees are directing their coordinated activities toward this goal. Each month the names of applicants and new members qualified are listed, according to Sections and Groups, in the SAE Journal.

Long-time members of the Society, those who have reached their 65th birthday and who have paid dues for 25 or more years, are benefiting by action taken by the Council whereby their annual dues are reduced to $10. The Society has 315 members in this group.

Student Enrollment High

For the sixth consecutive year the Society has established a new record in the number of its Enrolled Students. The total, as of September 30, was 5,848, as compared with 5,021 at the close of the previous fiscal year. During 1949–1950 former Enrolled Students applying for regular membership in the Society numbered 333, almost 20 percent of the total applications received.

Most of the Enrolled Students are members of the 33 SAE Student Branches on college campuses in the United States and Canada. Others are affiliated with informal SAE Clubs. Five new Student Branches were approved by the Council last year—located at Loyola University of Los Angeles, University of Colorado, Aeronautical University, Academy of Aeronautics, and Tri-State College.

SAE Student organizations obtain helpful assist-

ance and guidance from their Faculty Advisors and the Student Committees of Sections and Groups in their areas.

Meetings Activity Holds at High Level during 1950

Rewarding technical programs, new attendance records, expanded equipment displays, and dramatic special events featured the ten SAE national meetings held throughout the country during 1950. Presentation and discussion of 140 outstanding papers assured liberal "take-home pay" for the 9200 members and guests who attended technical sessions.

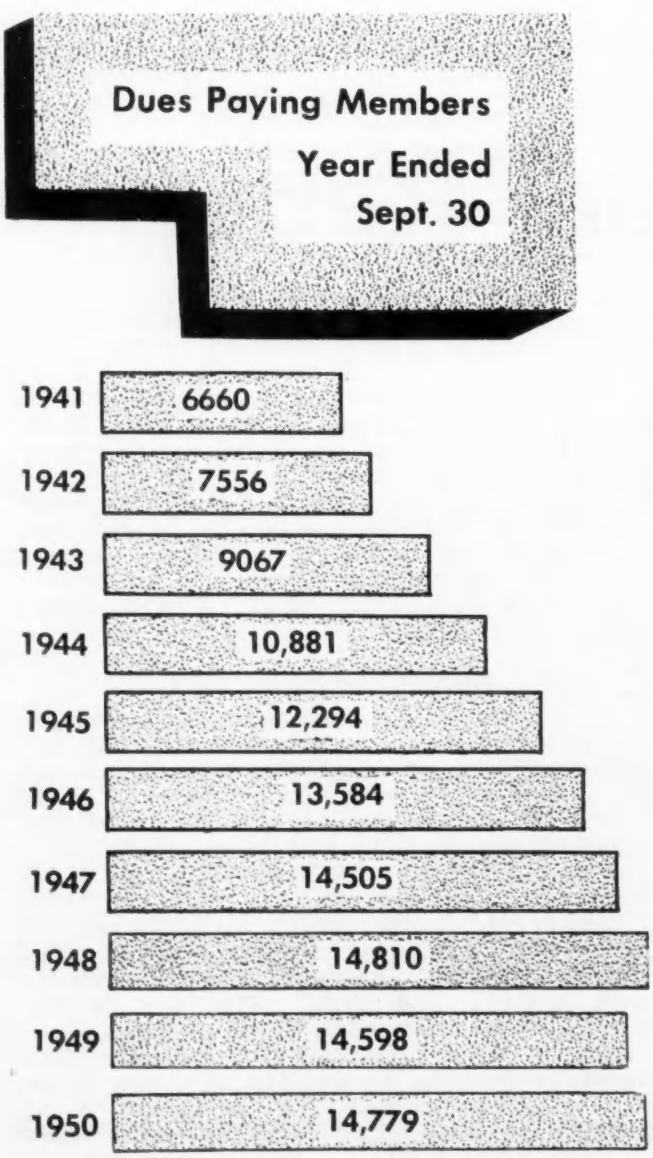
New attendance records were set by three meetings—the Summer Meeting at French Lick, the National Tractor Meeting in Milwaukee, and the National Diesel Engine Meeting in Chicago. Summer Meeting attendance, in fact, was held to a 1400 record only by the hotel capacity in the French Lick area. Informal round-table discussions and technical sessions of compelling interest were largely responsible for the capacity Summer Meeting turnout.

For the second successive year the one-day Production Clinic held during the National Passenger Car, Body, and Production Meeting drew hundreds of production engineers to the meeting to exchange practical on-the-job know-how. Success of these clinics promises their spread to other SAE national meetings.

1950 was also a banner year for the engineering displays that complement the SAE Annual Meeting and two National Aeronautic Meetings. The New York Aeronautic Meeting Display was expanded to more than twice its former size; and every exhibit booth was taken at the Annual and Los Angeles Aeronautic Meeting displays.

The first appearance in the United States of a jet-propelled airliner featured the Inspection Trip to New York International (Idlewild) Airport held in conjunction with the New York Aeronautic Meeting. There the A. V. Roe "Jetliner" gave a dramatic flight demonstration before over 300 members and guests who previously had inspected the latest in turbojet and turboprop powerplants and aircraft design in static display.

Equally popular were the three inspection trips held simultaneously on the last day of the SAE's second National Diesel Engine Meeting. Members and guests took their choice among trips to the new Sinclair Research Laboratory, Burlington Railroad Maintenance Shops, and the General Motors Electromotive Plant.



Publications Reflect SAE Technical Progress

Publications were able to reflect SAE production of technical material during 1950 more fully than in any recent year. Both SAE Journal and SAE Quarterly Transactions space was budgeted as high as in 1949, while the total number of papers presented (the source of SAE editorial material) declined slightly.

In SAE Journal, this combination of circumstances made available more space per paper and made 5.3 months the average time between presentation of a paper and publication of the Journal's abridgement.

In SAE Quarterly Transactions all papers approved for publication were printed in full, as in previous years, but the ready availability of space brought the average time between presentation and publication from 9.2 months to 6.7 months.

SAE Journal

Some abridgement or digest of every paper presented before the Society was printed in SAE Journal, as in previous years. More space than usual was devoted to feature-length articles drawn

from reports of SAE technical committees. Total number of editorial pages was 986 as compared to 942 in 1949 and 923 in 1948.

From each paper was drawn the material likely to be of most interest to all member-readers. The form of presentation was aimed at the same end. Special effort was made, for example, to present the main points of papers in illustrations and accompanying explanatory captions.

New features of general interest added during 1950 were (1) "Twenty-Five Years Ago"—items of fact and opinion taken from the pages of SAE Journal a quarter of a century ago, and (2) "SAE at the Colleges"—a series about SAE Student Branches, the colleges in which they operate, and the SAE alumni of those colleges. Continuance of both features during 1951 is contemplated.

Since the October, 1950, issue, SAE Journal has been printed on a machine-coated paper which brings out photographic illustrations more sharply, in addition to improving the general readability.

SAE Quarterly Transactions

For the first time since SAE Quarterly Transactions was established in 1947, the Society is offering a bound volume of the four issues of the Quarterly. On his 1951 dues bill, each member was given the option of (1) subscribing to Quarterly Transactions alone, (2) buying a bound volume of the four issues alone, or (3) both subscribing to the Quarterly and buying the bound volume.

Of the 190 papers received at SAE headquarters in 1950 following presentation at a National or Section meeting, 25% were approved by Readers Committees for publication. This compared with 19.8% of the 1949 papers and 25.4% of the 1948 papers which were so approved and published.

SAE Handbook

Preparation of the new $8\frac{1}{2} \times 11$ SAE Handbook for 1951 was begun early last fall. Change of size from the traditional $5\frac{1}{2} \times 8$ necessitates editing and resetting all of the material—which ran to nearly 1100 pages in the 1950 size. Every effort is being made to meet a May 15 publication date.

Special Publications

Copies of SAE meetings papers and technical committee reports distributed during the 1949–1950 fiscal year totalled nearly 86,000—as compared with nearly 110,000 in the previous fiscal year. Important among the items prepared during this fiscal year—and issued in October—were the new SAE Automotive Drafting Standards.

Public Relations

Important in recent public relations work have been the special feature stories about SAE and its work which appeared in important company and association house organs. Such special articles have now appeared in bulletins of the Automobile Manufacturers Association and the American Standards Association; and in house organs of such companies as Chrysler and Spicer.

These articles were in line with the continued primary aim of SAE public relations—to create favorable impressions about SAE among executives of the industries from which the Society draws its membership and among members and prospective members.

This aim was furthered also by continued routine publicizing of SAE meetings, SAE awards, and SAE technical committee work.

R. I. Potter
Membership
Committee
Chairman

W. S. James
Student
Committee
Chairman

G. A. Delaney
Meetings
Committee
Chairman

1400 Members Guide Local SAE Affairs

The strength of SAE's 41 Sections and Groups is reflected by the fact that last year some 1400 members of the Society participated in their programs as officers and committeemen.

These men cooperated locally and with the Society's Sections Committee to keep the SAE vigorous in their areas. They sponsored technical meetings, stimulated interchange of technical information and social contacts, cooperated with the SAE Placement Service for the benefit of members and local industry, worked with SAE students, and fostered membership growth.

Last year, an overall audience of 40,000 was present at 300-plus Section and Group meetings. Due to the splendid cooperation of engineer speakers and their companies, the local units heard excellent papers on practically every phase of automotive engineering. Technical meetings were interspersed with plant visits and social activities. Host Sections to national meetings worked with the sponsoring Professional Activity Committees to make them outstandingly successful.

T. B. Rendel
Publication
Committee
Chairman

M. C. Horine
Constitution
Committee &
Public Relations
Committee
Chairman

T. L. Swansen
Sections
Committee
Chairman

C. M. Larson
Placement
Committee
Chairman

W. H. Graves
Technical
Board
Chairman

Section status was granted by Council action, last year, to SAE organizations in Montreal and Mid-Michigan. These new Sections had been Divisions of the Canadian and Detroit Sections, respectively, which endorsed their requests for independent Section status and ceded to them portions of their territories.

Placement Service Job Openings Rise

The SAE Placement Committee reports a continuing flow of approving letters from both SAE members and employers. This is done on a budget of $3,600 per year and a cost per contact of $1.50, with no charge at all to the user of the Service.

The company list, which is 386 strong, provides some 200 inquiries per month for the 786 SAE members who are registered. Approximately two-thirds of these inquiries are for experienced men and one-third for recent graduates.

The current demand for SAE members is such that we currently have more job openings than a year ago and only 50% as many applicants.

SAE Placement Service gives high dollar return for the money spent, both in direct value to the member using the Service and in indirect value to the Society.

Technical Committees Renew Aid to the Military in 1950

The technical know-how of SAE members once again is being brought to bear on defense problems as the nation's rearmament program gets under way. Plans for rendering technical advisory service to the military on a broad range of pressing engineering problems are well developed.

Steps already have been taken to deal with some of the critical material problems which defense production makes inevitable. Almost a year ago, development of new aeronautical material specifications to meet a serious shortage of columbium was undertaken. Now, these specifications have been issued and are in use by jet engine manufacturers. About the same time, at the request of Army Ordnance, the SAE Iron and Steel Technical Committee undertook advisory assistance on a new Ordnance steel specification which will make substitutions to meet critical material situations much less of a problem for both Ordnance and industry than in World War II.

One outstanding result of the work of technical committees operating under the Technical Board is the first edition of the SAE Automotive Drafting Standards. These standards are the result of three and one-half years of intensive effort by the Steering Committee on this project and by fifteen subcommittees which it organized to develop detailed proposals. Close to 100 individuals participated actively. It is hoped and expected that these standards will find extensive use, not only in engineering departments of the automotive industry, but also in the teaching of drafting in the schools and colleges of the country. Drafting professors are showing a great interest in them. The Automotive Drafting Standards are still incomplete, and it is anticipated that when the second edition is published a year or more hence, it will include about six additional sections.

During the past year, under the direction of the Aeronautics Committee, more than 100 recommendations have been developed for aircraft utility parts standards. These recommendations have been transmitted through the Aircraft Industries Association to the Air Force and Navy for adoption as AN Standards. Included in these recommendations were standards for studs, representing the culmination of eight years of effort on a problem which initially appeared almost unsolvable.

The SAE Aeronautics Committee also has provided advisory assistance on numerous military equipment specifications. This work has covered not only the equipment itself, but also problems involved in its installation in aircraft. In addition, work was launched during the year on development of a series of recommended practices for cockpit layout and standardization. To date, agreements reached include standardized lighting arrangements and installations for commercial transport cockpits. This work was undertaken at the request of the Air Transport Association.

An extensive revision has been effected in the SAE Classification for Crankcase Oils. This revision is the result of two and one-half years of field research, checking and study by the automobile manufacturers and the petroleum suppliers, with cooperation by the CRC and Technical Committee B of ASTM Committee D2. The first step in this re-

A. T. Colwell
Finance
Committee
Chairman

B. B. Bachman
Treasurer

INCOME AND EXPENSE

October 1, 1949 to September 30, 1950

In Agreement with Haskins & Sells Audit

Income

Membership		
Dues Earned	$252,461.44	
Subscriptions Earned	89,536.10	
Initiation Fees	24,339.50	
Miscellaneous Membership Income	1,506.16	$367,843.20
Publications		
Journal and Transaction Sales	39,475.18	
Journal Advertising	271,839.00	
Handbook Sales—1949	8,169.75	
Handbook Sales—1950	7,175.00	
Handbook Advertising	12,450.00	
Aeronautical Publications	14,859.61	
Special Publications	29,115.22	
Miscellaneous Publications	2,864.97	385,948.73
National Meetings		
Guest Registrations and Papers Sold at Meetings	8,541.65	
8 Dinners	28,301.75	
3 Displays	18,794.00	
Summer Meeting	7,375.50	63,012.90
Interest & Discount		
Interest Earned	13,920.64	
Discount Earned	687.69	14,608.33
Total Member Service Income		831,413.16
Industrial Income for Technical Board Services—Exclusive of $31,999.39 Deferred		138,275.61
Total Income		$969,688.77

Expenses

Sections and Membership		
Sections & Student Branches	$ 15,281.41	
Sections Appropriations & Dues	50,975.00	
Membership	25,771.45	
West Coast Office	15,864.82	
Miscellaneous Membership Expense	2,763.70	$110,656.38
Pro-Rated Administrative Expense (15.9%)		29,758.20
		140,414.58
Publications		
Journal & Transactions Editorial	131,799.28	
Journal Advertising	121,323.01	
Handbook Mailing—1949	519.07	
Handbook Editorial—1950	48,712.69	
Handbook Advertising	2,714.18	
Aeronautical Publications	7,242.02	
Special Publications	24,365.88	
Miscellaneous Publications	16,985.08	353,661.21
Pro-Rated Administrative Expense (50.8%)		95,076.51
		448,737.72
National Meetings		
Department Expense	33,328.70	
Cost of Registrations and Papers	4,703.80	
9 Meetings	23,570.47	
8 Dinners	25,639.04	
3 Displays	5,616.65	
4 Awards	697.09	93,555.75
Pro-Rated Administrative Expense (13.4%)		25,079.23
		118,634.98
Administrative Exp. Pro-Rated above to Member Services	(149,913.94)	
Total Member Services Expense		$707,787.28
Technical Board Services		
Technical Committee Operations	$106,811.55	
CRC Appropriation	25,000.00	
Miscellaneous Expense	6,464.06	138,275.61
Pro-Rated Administrative Expense (19.9%)		37,244.53
		175,520.14
Total Direct Expenses	696,148.95	
Total Administrative Expenses	187,158.47	
Contingent Fund	—	
Total Expenses		883,307.42
Added to Reserves		86,381.35
Total Income		$969,688.77

vision was to omit oils of more than 110 Saybolt seconds at 210 F, thus eliminating SAE 60 and SAE 70 grades. Next step was to specify the viscosities of all regular SAE oils (SAE 20, 30, 40 and 50) at 210 F, instead of specifying the lighter grades (SAE 20, 30 and 40) at 130 F. The former automobile manufacturers' classification of 10W and 20W was incorporated in the official SAE classification, the SAE 10 and the 10W oils becoming SAE 10W. Lastly, as the result of extensive field research, SAE 5W was adopted with maximum viscosities specified at 0 F to provide a standard grade for very low temperature operations and having good starting characteristics to replace the use of 10W oils diluted with kerosene.

A revised classification of rubber and synthetic rubber compounds for automotive and aeronautical applications, was completed during the year by the Joint SAE-ASTM Technical Committee on Automotive Rubber, and will shortly be presented to the Society for adoption as an SAE Standard. On the basis of industry experience with the former classification and in the interest of economy in manufacturing and usage, the total number of classified compounds is reduced from 158 to 99, or a reduction of about 37% in the previous number. The former Type R, Classes RN and RS Compounds have been combined into a single Type R Non-Oil Resistant group, totalling 37 compounds instead of 91, while

BALANCE SHEET
As at September 30, 1950
In Agreement with Haskins & Sells Audit

Assets	
Cash—Unrestricted	$172,943.49
Restricted	13,169.51
Notes & Accounts Receivable—Less Reserves	19,856.00
Securities—Cost Value	617,653.94*
Accrued Interest on Securities	4,284.12
Inventories	885.41
Deposits	550.00
Furniture and Fixtures, SAE Offices	1,000.00
Deferred Charges and Prepayments	54,794.53
Total Assets	$885,137.00

Liabilities & Reserves	
Accounts Payable	$ 15,210.12
Section Dues Payable	7,418.00
Deferred Credits to Income:	
Member Dues Received in Advance	86,941.33
Industrial Income for Technical Board Services	73,947.55
Subscriptions	17,217.89
Others	14,940.27
Reserves for Unexpended Contributions	9,739.82
Reserve for Retirement Plan Contributions	14,919.10
General Reserve	644,802.92
Total Liabilities and Reserves	$885,137.00

* Book Value—(Quoted Market or Redemption value at 9/30/50—$601,838.76)

the three classes of Type S compounds (Types SA, SB and SC) remain approximately the same. The basic physical properties as well as the test requirements and prescribed testing methods, together with a system of suffixes for denoting additional tests have likewise been brought up to date with current practice.

In line with the strong trend to automatic transmissions involving hydraulic torque converters, a Hydrodynamic Drive Technical Committee has been organized. It has reached agreement on terminology intended to provide a common engineering language on these drives. This terminology deals for the time being only with physical parts and significant dimensioning as it is agreed that actual standardization of parts, materials, etc., cannot be undertaken until design and performance have been further developed and become more stabilized. Work also is going forward on a standard laboratory testing code, so that performance data of different companies or groups will be comparable. Consideration is also being given to the establishment of a standard system of symbols for use in hydrodynamic drive engineering, design and performance.

A complete and voluminous report on the Low Temperature Properties of Ferrous Materials has been developed by the Iron and Steel Technical Committee. This report contains a great deal of hitherto unpublished data and information and is intended to serve as a guide in the selection of ferrous materials to be used in low temperature applications. It is anticipated that the information it contains will be of great value both to the military and to industry in the development of equipment suitable for use in the Arctic.

Other 1950 products of SAE technical committee work include standards and recommended practices for marine propeller shaft ends and couplings, splines, tool and die steels, measurement of case depth, characteristics and heat treatments of steels, revisions in specifications for turn signals and other automotive lamps, low and high tension cable, body hardware, and high pressure tube fittings.

Finance Committee Nears Reserve Objective

The Finance Committee has had an objective of sufficient reserves to provide a good guarantee that vital services could be maintained in good times and bad. Specifically, the objective has been $750,000 for member service activities and with current reserves at $644,000 the objective is now in sight.

The Finance Committee recognizes, of course, that the many things done to hold down expenses and permit the highly satisfactory results of the last two or three years may be more than overcome by the generally increasing costs with which we are all faced. In addition to this, provision in the new budget has been made for additional expenditures in the technical committee area because of prospective demands from the military similar to those received by SAE during World War II.

In connection with the technical work, an earmarked backlog has been built up which solidifies this important service that SAE renders to industry. Naturally, this position has been made possible through industry's generous support of the program and the backlog may be needed if there is any material increase in demands for this work.

To offset higher publication costs, the SAE Council has approved an increase in advertising rates which, it is hoped, will ultimately carry us back to the advertising revenue level of 1948 and 1949.

With respect to expenses, the new budget shows a number of substantial savings which are permitting a budgeted black figure for the current fiscal year of $45,000. Included in the new budget is an additional $10,000 which the Council has approved for expansion of the Society's retirement plan.

In view of uncertainties, the Finance Committee will continue its past practice of reviewing operations on a quarterly basis and going back to the Council with any recommendations for budget changes which may seem desirable as the year progresses.

Treasurer's Report

The audited financial statement for the fiscal year ended September 30, 1950, appears on page 23 of this report and reflects a sound financial condition.

Expenditures for the fiscal year amounted to $883,000, with income at $969,000—a difference of $86,000 which was carried to reserves.

The Society's cash position is substantial and the balance sheet also shows investments of $617,000—all in U. S. Government obligations.

TURBINE-ENGINE ANTI-ICING
Tested Atop Mt. Washington

EXCERPTS FROM PAPER* BY

P. M. Bartlett, Installation and Accessories Branch, Power Plant Division, Bureau of Aeronautics

T. A. Dickey, Aeronautical Engine Laboratory, Naval Air Material Center

* Paper "Gas Turbine Icing Tests at Mount Washington, New Hampshire," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950.

NEW HAMPSHIRE'S Mount Washington is providing free plenty of conditioned air for Project Summit, the joint Air Force-Navy-industry effort to develop turbine-engine anti-icing means. The cost involved is the considerable effort of going to the mountaintop and staying there to test under icing conditions.

Mount Washington lies in the northeast storm track and has a fairly smooth approach. Rapid lifting of approaching air by a vertical distance of almost a mile, over an approach run of several miles, creates the condensation and supercooling of the moisture necessary for icing conditions. The lifting process also creates the supervelocities over the summit and the characteristic high winds for which the mountain is famous. Statistics show, for ex-

Fig. 1—Summit of Mount Washington

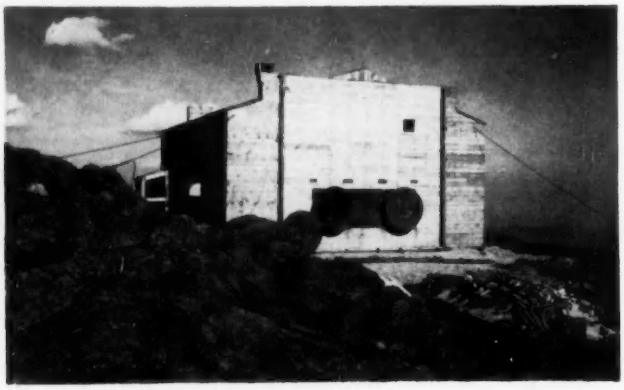


Fig. 2—Icing-test hangar showing bellmouth air inlets

ample, that during the winter season icing conditions occur approximately 25% of the time and that in December the wind velocity exceeds 100 mph 17% of the time and exceeds 50 mph 98% of the time.

Fig. 1 is an aerial view of the summit of Mount Washington showing the nature and location of the various facilities. The icing-test hangar is seen at the left center of the picture, located in what is commonly referred to as the lower parking area. Engine and test-section packing cases can be seen lined up to the right of the building. In the lower left, can be seen the eight 4000-gal tank trailers used for gasoline storage. On the actual summit, the building immediately in front of the radio tower is the Mount Washington Observatory. The dark building to the right is the Yankee Network Building, now under lease to the Air Materiel Command and used for living quarters and shop work. To the left of the tower is the power house, which furnishes all electrical power to the facilities on the summit.

Fig. 2 is a view of the hangar showing the bellmouth air entries. These openings must be kept covered at all times that testing is not in progress to prevent their becoming filled with ice and blowing snow.

The schematic sketch of the interior of the icing-test hangar, Fig. 3, shows the twin test stand arrangement with bellmouth air inlets for drawing icing conditions into the engines or test components. The north stand is, in effect, a wind tunnel with the J33 turbojet engine providing the means of drawing air through the test sections. The test sections are always built to a standard length and mounting-flange configuration to permit rapid installation and removal. Ahead of the test section is the instrumentation section, which includes provisions for measuring meteorological conditions and airflows, and for mounting cameras to record test-section ice formation.

The south stand is equipped for mounting complete turbojet engines, but, in all other respects, is similar to the north test stand. A thrustmeter is being installed on the south stand for this winter's operation. On either side of the test stands are the control rooms as well as generators, heaters, air compressors, and other supporting equipment. The jet engines exhaust through the open door at the end of the building.

Complete test set-ups appear on each test stand in Fig. 4. The test section ahead of the J33 on the north stand represents the inlet of the Allison XT40 turboprop engine. A Westinghouse J34 turbojet engine is shown on the south stand. This picture also provides some idea of the equipment which is crowded into this small test facility when operations are actually under way. In addition to the actual equipment under test, a complete inventory of maintenance equipment is stocked, much of it in two small side rooms over the control rooms. This equipment covers the range of welding gear, electrical and plumbing equipment, instruments, fuel lines, and even K rations.

The Air Materiel Command and Bureau of Aeronautics sponsor the facility on an equal basis, with intercoordination as necessary. The Climatic Projects Section of the Air Materiel Command administers the operation of the Aeronautical Ice Research Laboratory, which in turn assigns a detachment of its personnel to Mount Washington. The Power Plant Laboratory of the Air Materiel Command maintains technical coordination with aircraft and engine manufacturers who are engaged in powerplant development programs for the Air Force and who desire to conduct tests under Project Summit. On a similar basis, the Power Plant Division of the Bureau of Aeronautics maintains direct coordination with the Aeronautical Engine Laboratory, which assigns a detachment of its personnel to the test facilities. The Power Plant Division also maintains technical coordination with the aircraft and engine manufacturers engaged in similar developmental programs for the Navy.

In actual operations at Mount Washington the AIRL is responsible for all administrative matters including transportation, personnel conduct, living and messing facilities, communications, office facilities, and similar functions. The AEL is responsible for maintenance and the operation of the icing-test hangar and its associated equipment. During actual testing, the AEL and AIRL personnel are responsible to the representative of the manufacturers for direct physical and technical assistance as neces-

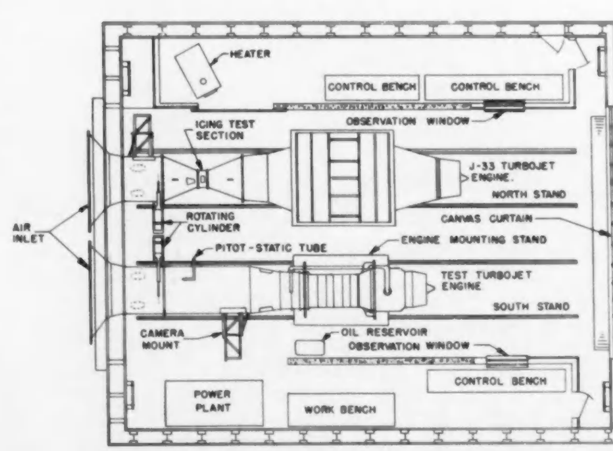


Fig. 3—Schematic arrangement of icing-test hangar

sary. Generally speaking, the personnel assigned by the government work in their respective fields of specialization. The assistance furnished by the AIRL personnel involves maintenance and operation of meteorological instrumentation, recording of meteorological test data, operation of the water spray equipment, and similar functions. The AEL personnel generally maintain and operate the J33 engine, provide fuel, electrical power, compressed air, and perform other similar duties.

The services require that each manufacturer participating in Project Summit assign at least one qualified engineer to the facility during his test period. This engineer must be capable of supervising and guiding his company's program on the spot, scheduling each successive test run on the basis of previously accumulated test data.

The icing season at Mount Washington extends from mid-October to mid-April. The season is divided into 20-day periods for test section tests on the north stand and into 30-day periods for complete engine tests on the south stand. Each engine or aircraft manufacturer desiring to conduct tests is assigned one or more of these periods. Whenever practical, each participant is assigned one test period in the fall with additional periods later in the season as desired.

Each test period includes the installation of the engine or test section at the start of the period and the subsequent removal from the test stand at the end of the period. Therefore, planning and design of a test installation for ease of setting up and removal is an important factor in the amount of time during a test period which is actually available for testing. In most cases it has been possible to complete a test set up on the north stand in two days and to remove it in one day, leaving up to 17 days for testing during a period. The greater length of time required to install and remove a complete jet engine with its complex test instrumentation and with the limited manpower situation is the reason for assigning 30-day periods to the south stand. The assignment of longer periods would complicate the personnel problem, since the company representatives are usually assigned to remain at the summit for an entire test period.

Preparations at Mount Washington for the winter's icing season start about the first of September

Project Summit's Contributions . . .

Thanks largely to Project Summit, there is no longer any question as to whether a successful anti-icing system can be designed. Efforts are now being directed to the optimum system from the standpoint of cost, weight, complexity, maintenance, and effect on engine performance.

The method of engine anti-icing which is universally popular within the engine industry consists of direct heating of the critical components of the engine inlet. The greatest problem in this method is one of obtaining the tremendous unit area heat release necessary for objects of small dimension.

Some concept of heating requirements may be gained from considering that a small wire, carrying sufficient electric current to melt it in relatively slow moving dry air, will drop to a surface temperature close to ambient when exposed to icing conditions. Unit area heat release requirements for anti-icing vary somewhat inversely with the characteristic dimension of the object to be anti-iced such that when compared with wing anti-icing, the unit area heat release for such small objects as inlet guide vanes is infinitely greater than that required for the large wings. Inlet screens, for those engines which are so equipped, require heat inputs per unit area so great that, up to now, anti-icing of inlet screens has not been considered practical.

The general usage among the engine industry for solving the icing problem for the various critical components is:

Inlet Screens—Retractable screens with retraction before icing is encountered.

Inlet Guide Vanes—Hollow heated vanes utilizing heated compressor discharge air or combustion-chamber hot gas as the heat-transfer medium.

Struts and Bearing Supports—Hollow heated construction similar to guide vanes or use of electrical surface heating.

Accessory Fairing — Double-wall construction with hot air, hot gas, a hot oil, or use of electrical surface heating.

Heat-transfer data from components of this nature were almost completely lacking several years ago. The results of the best anti-icing system design estimates, when exposed to icing conditions during the first season at Mount Washington, demonstrated the inadequacy of anti-icing knowledge. The shortcomings of the various designs during the first winter, however, were corrected by last season, and the ability to design an adequate engine anti-icing system finally was demonstrated.

with the first several weeks spent in putting the hangar in order. All test set-ups are scheduled to arrive by September 15th. The next 30 days are spent in conducting trial installations. The purpose of these trial installations is to insure that each test set-up is functioning properly and to make necessary changes before the eight-mile Toll Road to the summit is closed to heavy transportation by an early snowfall. Actual testing gets under way in October and continues until April with the exception of a two-week shut down for the Christmas-New Year holiday period.

During the summer, the summit of Mount Washington is accessible by cog railway which starts from the west side of the mountain and by automobile Toll Road which starts from the east side. Up to the present time, the cog railroad has shut down each fall as soon as the steam-engine water-supply system along the railroad becomes subject to permanent freezing. Aside from the water supply problem, the cog rack, in its present arrangement, becomes filled with ice and precludes the possibility of winter operation without some rearrangement.

Drifting snow also closes the upper half of the eight-mile automobile Toll Road in mid fall. Thereafter the summit is not accessible to any form of vehicular transportation until spring. The heavy icing which accompanies the frequent storms on Mount Washington, together with the continual blowing and drifting of snow, would make ploughing a major operation.

Until some improvement can be made to the transportation system, it is necessary that all heavy equipment be moved in by early fall. Once the Toll Road is closed, all further transportation of equipment is limited to pack boards. Track-laying weasels are maintained at the base of the mountain by the AIRL to transport personnel and their gear over the first four miles, which distance is below the timber line. From the 4-mile point, it is a long hard journey to the summit, either wading through drifts of powdery snow or creeping over steep stretches of windswept ice. Spiked crampons strapped to one's feet are the only means of maintaining a footing on the ice. If a crampon breaks, which is not unusual, a person can become helpless under bad ice conditions. For this reason most experienced personnel carry an extra pair for added safety.

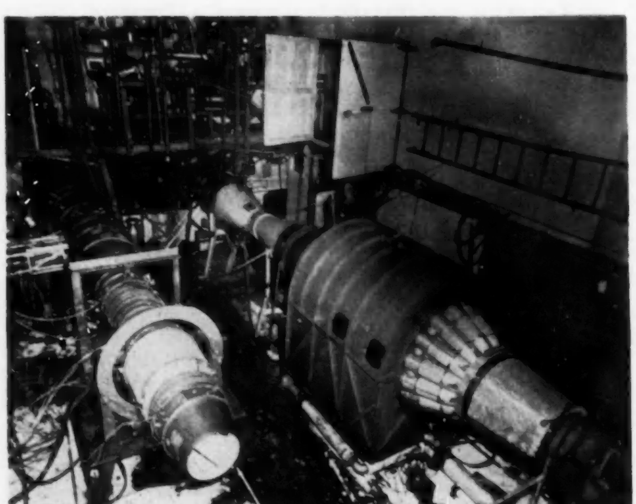


Fig. 4—Engine test set-ups

The most severe drifting occurs over a two-mile section of the Toll Road between four and one half and six and one half miles from the base. When conditions permit, a jeep, which is kept at the summit during the winter, attempts to meet personnel at the 6½-mile point.

In one instance two years ago, it was necessary to transport some heavy J47 engine parts to the summit during early April. The aid of a detachment of the Quartermaster Corps stationed at the base of the mountain for cold weather tests was enlisted. Some 20 men using rope harness spent two complete days hauling the 400-lb crate from the 4½-mile point to the 6½-mile point, where it could be loaded on the jeep for the remainder of the trip to the summit.

Communication facilities, which originally were limited to two-way radio contact with the AIRL office maintained at the Glen House at the base of the mountain, now include a commercial radio-telephone system which permits direct contact between the summit and the rest of the country. This telephone system, which was installed last winter permits the manfacturers' test personnel to maintain direct contact with their home offices and has considerably reduced the isolation of the facilities.

In addition to radio-telephone, a land telephone line runs between the base and summit; however, storms continually break this line. In the winter it is possible to maintain it only between the summit and the 6-mile shelter. This is accomplished only with considerable effort since the line is continually disrupted, and the location of a break often means digging it out of several feet of snow at frequent intervals.

Maintenance of communication with the 6-mile shelter is particularly important for safety of travel on Mount Washington. Whenever a party departs from the base to climb to the summit, the summit is notified by radio-telephone. The party is carried the first four miles by a "weasel" and then must climb the remaining four miles. It is a strict rule that all personnel report in at the 6-mile shelter, so that if a party is overdue and the summit receives no report of arrival at the 6-mile shelter, a rescue operation may be started and the search area is immediately confined between four and six miles from the base. Correspondingly, if arrival of the party at the summit is appreciably delayed after report of departure from the 6-mile shelter, a search can be confined to the two-mile section between 6 miles and the summit. Considering the long list of hikers who have met disaster in the merciless winter weather of Mount Washington, those responsible for safety feel it is significant that no casualties or other serious difficulties have occurred under Project Summit.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

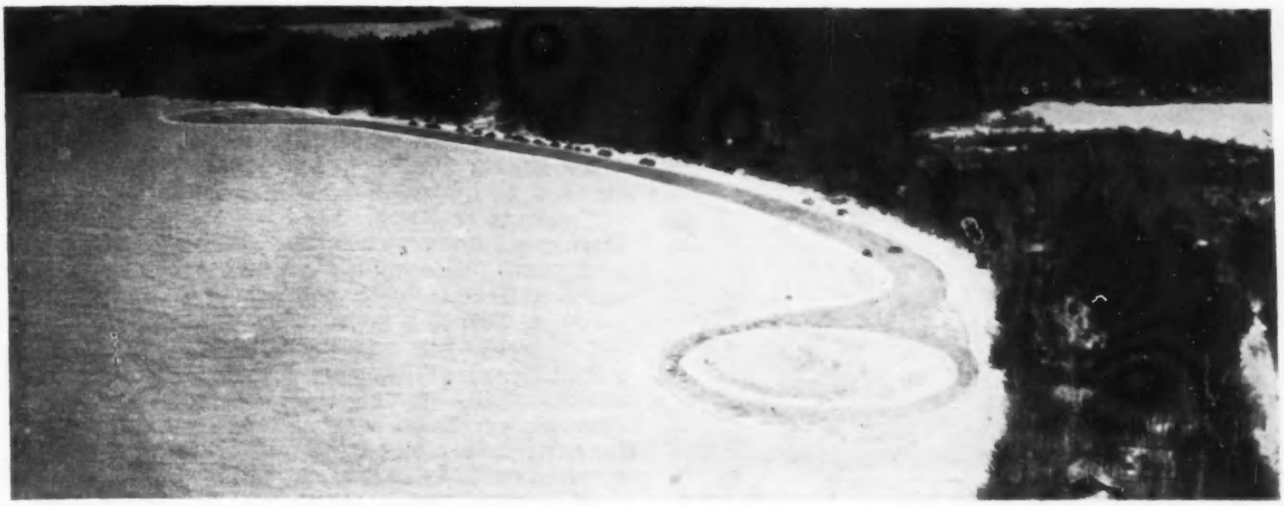


Fig. 1—Truck traction and stability tests were conducted on this quarter-mile long, 200-ft wide ice course on Pine Lake, near Clintonville, Wisc. The 16 to 20-in. thick ice surface was cleared of snow, shaved, and swept with a power broom. It was free from sand and dirt, and as smooth as, or smoother than, road ice

Vehicle Drive Stability Checked in Ice Skid Tests

EXCERPTS FROM PAPER* BY

A. H. Easton, Director, Truck Research Project, University of Wisconsin, College of Engineering, Engineering Experiment Station.

* Paper "Traction and Stability of Front, Rear, and Four-Wheel Drive Trucks," was presented at SAE National Transportation Meeting, New York, Oct. 17, 1950.

TRUCK traction and stability tests on the ice of Pine Lake, Wisconsin, Fig. 1, showed that four-wheel drive is safer than either front wheel or rear wheel drive on surfaces with low friction coefficients. Two heavy-duty trucks were used for these tests. The stability test results apply to all motor vehicles and road surfaces, if application of brakes or excess torque makes a given set of wheels break traction.

Behavior of front-wheel drive was shown to be good on the straightaway, but undesirable on a curve. Traction provided by front-wheel drive is a minimum for load distribution normally found in trucks.

The rear-wheel drive vehicle, while superior to the front-wheel drive in traction, is apt to go into a flat spin when excess torque is applied to the driving wheels, either on a straightaway or curve.

The four-wheel drive vehicle, with properly equalized torque and load distribution, gives maximum traction. This in itself makes for a safer vehicle because it reduces the likelihood of the wheels losing traction. Not only can this type drive hold its course on a straightaway, but the vehicle moves sideways on a curve if the wheels lose traction. This is a definite advantage in regaining control.

The test program also yielded some interesting conclusions concerning vehicle control on an ice curve, after the vehicle has started to skid because of excessive speed.

For example, the front, rear, or both axles may skid with each of the three drive types. With all three, reducing speed will regain vehicle traction if the front axle skids first. If the rear axle skids first with front and four-wheel drives, it is possible to keep the vehicle from going into a flat spin by applying excess power to the front wheels. This moves the entire vehicle sideways, which permits recovery as soon as the rear wheels begin to roll.

Rear wheels skidding first with rear wheel drive presents a different situation. If the skid goes so far that steering no longer is effective, the driver has no means of preventing the vehicle from continuing into a flat spin.

Test results also showed that delivering power

Fig. 2—Vehicle path on a straightaway with the rear wheels locked

Fig. 3—Vehicle path on a straightaway with the front wheels locked

through the steering wheels prevents loss of steering control by keeping the front wheels from locking during braking. This makes it possible to stop in less distance on a curve with a live front axle than with a dead one. Incidentally, the braking distance on the curve with four wheels driving and with four wheel brakes averaged 9% less than with rear-wheel drive and four-wheel brakes.

To study stability of the various type drives, a four-wheel drive truck was arranged so that brakes and power could be applied to the front and rear axles separately or in combination. This vehicle could be used as a front, rear, or four-wheel drive.

Two types of test were used to determine relative stability: (1) brakes were locked on the straightaway, and (2) excess torque was applied on both a straightaway and a curve. Behavior of the vehicle for various braking conditions and arrangements is pictured in Figs. 2 to 6.

Analysis of forces acting on the vehicle wheels for each case explains the behavior. In analyzing this action, these two facts are important. First, a rolling wheel is capable of resisting forces perpendicular to the plane of rotation. Second, a locked wheel is nondirectional in its ability to resist forces.

In the first case, applying rear wheel brakes, some sliding takes place. External forces acting on the vehicle are shown in Fig. 7A. Under this condition, the sum of moments acting about the center of gravity is zero. The vehicle will continue to travel on the tangent.

But suppose the vehicle is given a small angular velocity about some point "O," from a source such as superelevation or wind, no matter how small. Immediately forces start acting to throw the vehicle out of control. Now the analysis, shown in Fig. 7B, is as follows:

The instantaneous velocity of the center of each wheel, V_{c1}, is determined from the resultant of the velocity of translation and the angular velocity. Because the rear wheels are locked, the instantaneous velocity between each rear tire and the ice is equal to that of the center of the wheel. As a result the resisting forces at the rear wheels are opposite in direction to the resultant velocity at the center of

Fig. 4—Vehicle path on a curve with the front wheels locked

Fig. 5—Vehicle path on a straightaway with four wheels locked

each wheel and equal to u_s W, where u_s is the coefficient of sliding friction and W the normal weight on each wheel.

At the front wheels, because they are rolling, the instantaneous velocity between the tire and the ice in the plane of the wheel is zero. However, the instantaneous velocity at the center of each front wheel does have a component perpendicular to the plane of the wheel. A relative velocity between the front tires and the ice will be generated in this direction. The resisting forces then will be opposite in direction, and, therefore, perpendicular to the plane of the wheels.

The magnitude of these forces will be equal to the u_r W, where u_r is the coefficient of rolling friction. From experimental data on ice, u_r is equal to at least twice u_s. Therefore, the forces acting at the front wheels will be at least twice those acting at the rear wheels. Taking moments about the center of gravity, which is assumed to be at the geometric center for ease of calculation, the sum of the moments acting in a counterclockwise direction exceeds that in the clockwise direction. As a result the vehicle goes into a flat spin about a vertical axis.

In Fig. 7C, the front wheels are turned in the direction of the instantaneous velocity, V_{ci}. The forces u_r W are no longer present, and the forces acting tend to turn the vehicle clockwise and restore it to its original direction of motion.

It is difficult, however, for even the best drivers to maintain the front wheels in the plane of the instantaneous velocity. As soon as even a small angle exists between the plane of the front wheels and the instantaneous velocity, the full value of u_r W begins to act. This accounts for the instability of a vehicle under these conditions.

Fig. 8A shows the forces acting when only the front wheels are locked. Note that the forces are in equilibrium. If it is assumed in this case as before that the vehicle has some angular velocity due to superelevation or wind, the forces acting are shown in Fig. 8B. In this case, the forces acting at the front wheels will be equal to u_s W and opposite

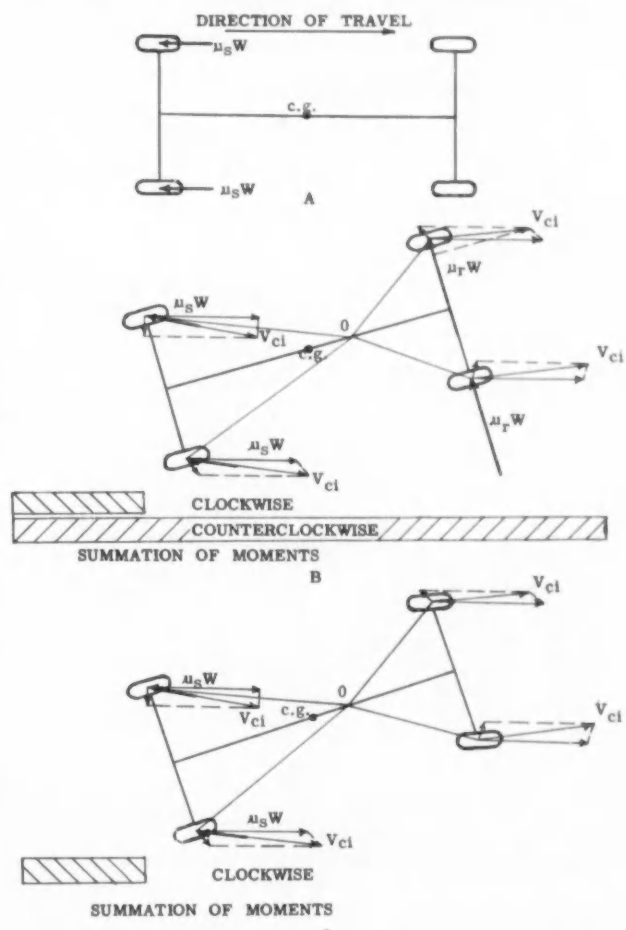


Fig. 7—External forces acting on a vehicle with the rear wheels locked

in direction to the instantaneous velocity of the center of the wheels. Likewise the forces acting on the rear wheels will be perpendicular to plane of the rear wheels.

Taking moments about the center of gravity and remembering that u_r W is equal to or greater than 2 u_s W, then by inspection the sum of the moments acting to turn the vehicle clockwise exceeds that acting to turn it counterclockwise. As a result the vehicle, instead of being thrown into a flat spin by the forces acting, is turned so that the longitudinal axis is parallel to the instantaneous direction of motion of the center of gravity. This is shown on a straightaway in Fig. 3 and on a curve in Fig. 4. Although under this condition there is complete loss of steering control, it can be regained as soon as the front wheels are allowed to roll.

If all four wheels are locked when the vehicle is traveling straight ahead, the forces are in equilibrium as shown in Fig. 9A. If the vehicle attains a transverse velocity as shown in Fig. 9B, the forces acting are again in equilibrium. If the vehicle attains an angular velocity, the moments of the forces acting to throw it out of control are exceeded by those tending to keep it in control. (This can be seen in Fig. 9C.)

Action of a vehicle on ice with all four wheels

Fig. 6—Vehicle path on a curve with four wheels locked

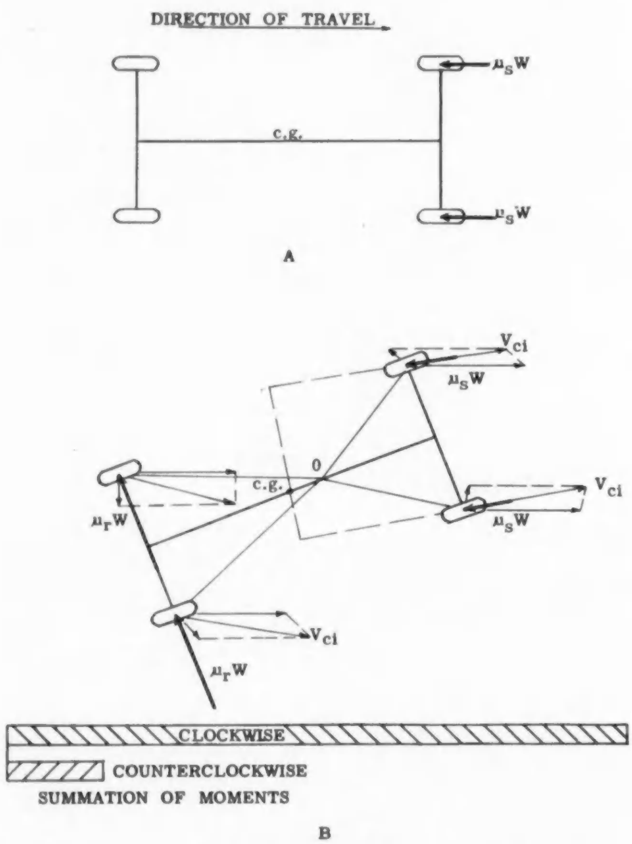


Fig. 8—External forces acting on a vehicle with the front wheels locked

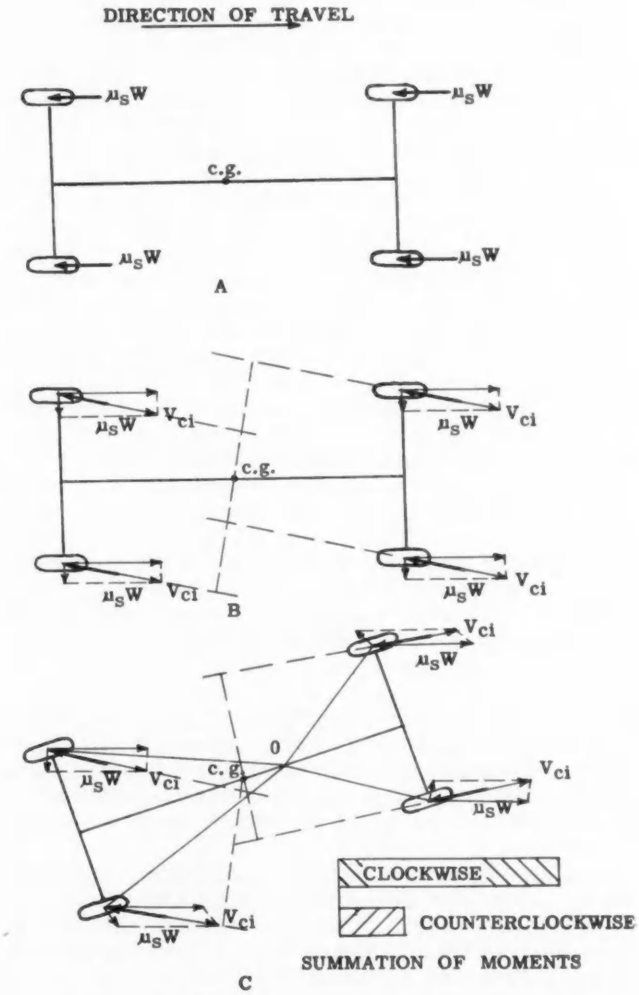


Fig. 9—External wheels acting on a vehicle with four wheels locked

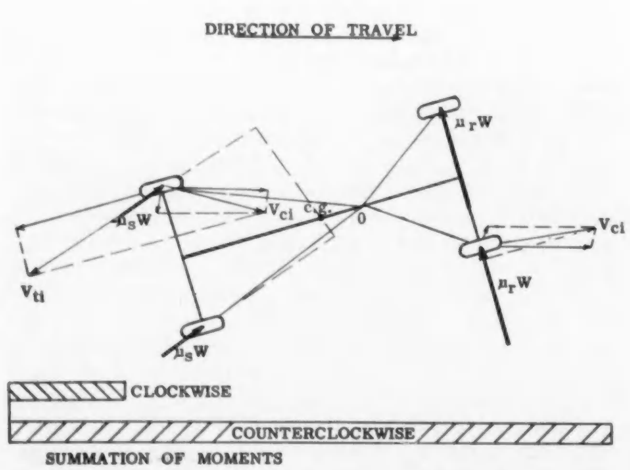


Fig. 10—External forces acting on a vehicle with rear wheels spinning

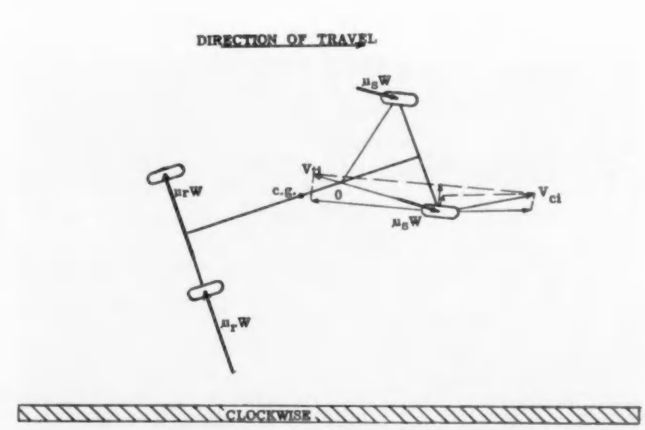


Fig. 11—External forces acting on a vehicle with the front wheels spinning

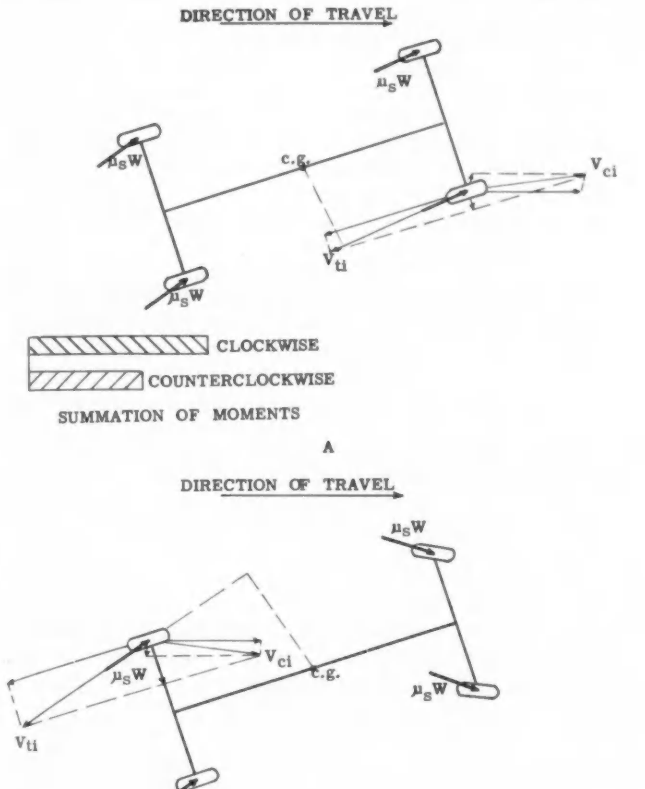


Fig. 12—External forces acting on a vehicle with four wheels spinning

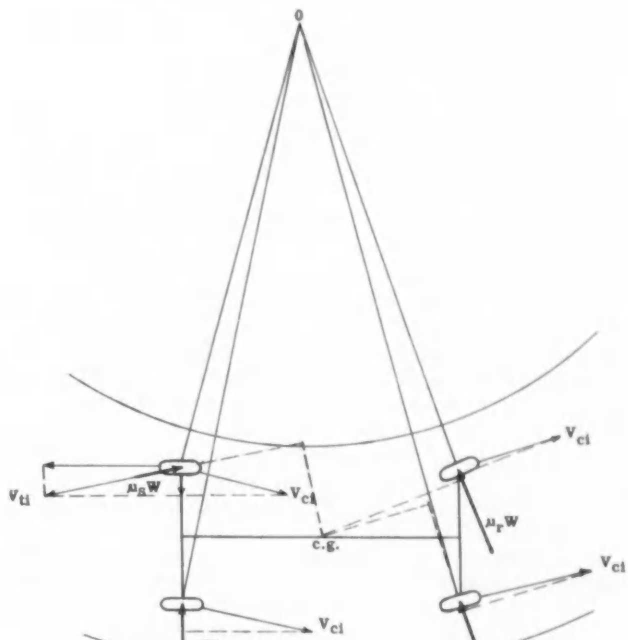


Fig. 13—External forces acting on a rear-wheel drive vehicle negotiating a turn, with excess torque on the driving wheels

locked is in accord with this last statement. Occasionally the vehicle may go into a slow flat spin. This may be due to a variation in the coefficient of friction at any one of the wheels. The action of a vehicle with all wheels locked on a straightaway is shown in Fig. 5, and on a curve in Fig. 6.

Consider now the second type of demonstration on a straightaway, the application of excess torque to the driving wheels or causing the driving wheels to spin. As long as the longitudinal axis of a rear drive vehicle is parallel to the direction of travel, the vehicle is in equilibrium. But as soon as the vehicle attains a small angular velocity, then it is unstable as shown in Fig. 10.

The instantaneous velocity between the tire and the ice, V_{ti}, is the resultant of the peripheral velocity of the wheel and the components of the velocity of translation and the angular velocity parallel to the axis of the rotation of the wheel. V_{ti} determines the direction of the force u_s W. The sum of the moments about the center of gravity is again greatest in the counterclockwise direction, so that the vehicle will go into a flat spin.

As before, turning the front wheels exactly into the plane of the instantaneous velocity, V_{ci}, removes the forces which throw the vehicle out of control. On ice maintaining the front wheels in the plane of the instantaneous velocity was difficult; hence, "fishtailing" occurred with the application of excess power on the rear wheels caused by overcorrection with the steering wheels.

If excess power is applied to the front wheels only, they can be used to add to the restoring moment provided by the rear wheels in case the vehicle attains an angular velocity. This is shown in Fig. 11. On ice a front-wheel drive vehicle recovered quickly when deliberately thrown into a flat spin. With the front wheels spinning and incapable of taking side forces, there was some loss of steering control, but it is not as complete as with the front wheels sliding.

Excess power applied to the wheels of a four-wheel drive vehicle produces forces at the four wheels, the direction of which are determined by the direction of V_{ti}. Their value will be u_s W. Under the condition shown in Fig. 12A the vehicle is very nearly in equilibrium. There is a net moment tending to prevent rotation in a horizontal plane if the front wheels are in the straight ahead position.

On ice a four-wheel drive truck showed no tendency to "fishtail" when excessive torque was ap-

plied to the wheels. If subjected to a superelevation the entire vehicle moves parallel to itself down the grade. If such a vehicle is deliberately thrown into a skid, recovery is rapid because of the ease in regaining traction. Also it is possible, as shown in Fig. 12B, to utilize the forces acting at the front wheel to aid in recovery.

In addition to considering braking and application of excess torque on the straightaway, a third and equally important condition is now analyzed. It is the negotiation of a turn by each type of drive, during which excess torque is applied to the driving wheels.

As shown in Fig. 13, front wheels provide forces for acceleration of the vehicle toward the center of the turn in a plane perpendicular to the plane of rotation. Maximum value of these forces will be u_r W. At the rear, these forces are acting also until the rear wheels begin to spin. At the instant the inside rear wheel begins to spin, the direction of the resultant force is nearly in the plane of the wheel. When the inside wheel brakes traction, because of the added load, the outside wheel begins to slide. Then the value of the forces acting at the rear decreases from u_r W to u_s W. The moment arms about the center of gravity also are reduced so that the summation of the moments tending to turn the vehicle counterclockwise exceed those acting in the clockwise direction. The vehicle goes into a skid on the turn.

As this happens, the moment arms of the forces at the rear wheels lengthen; but their value remains equal to u_s W, which is not more than half of u_r W acting at the front wheels, so the skid continues. This corresponds to the actual behavior of a rear-wheel drive truck on lake ice under these conditions. It was easily thrown into a flat spin by the application of excess torque on the driving wheels while negotiating a turn.

With a front-wheel drive vehicle on the same turn, the clockwise moments exceed those in the counterclockwise direction so that the front wheels leave the curved path. The forces acting are shown in Fig. 14. The forces at the rear wheels act to maintain the longitudinal axis of the vehicle in line with the instantaneous direction of travel of the center of gravity of the vehicle. Thus, the vehicle leaves the curve on a tangent to its original path. This was found to be true with the converted front-wheel drive truck. There was a loss of steering control, but no tendency to go into a flat spin.

Condition in Fig. 15, in which all four wheels are driving, is just before the wheels begin to spin. The forces producing acceleration of the vehicle toward the center of the turn are acting perpendicular to

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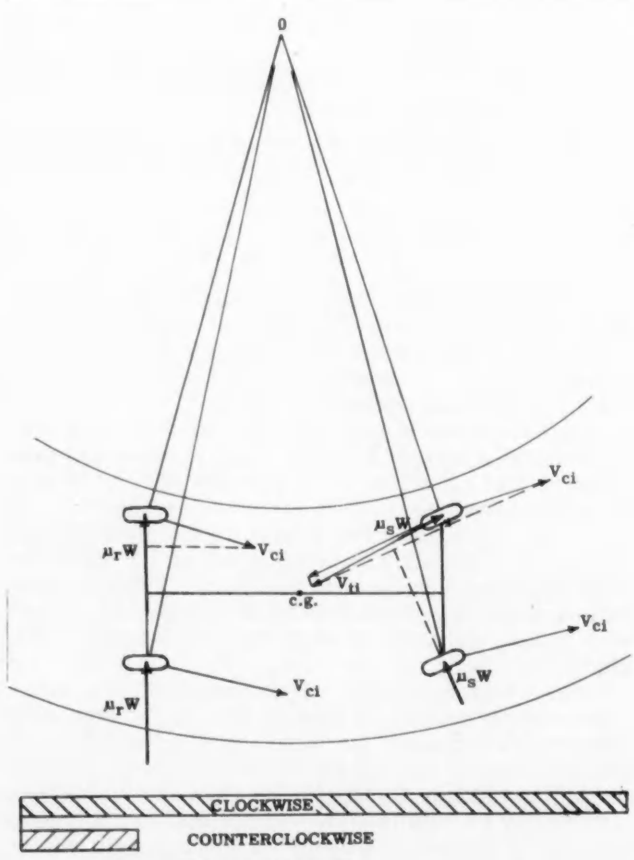


Fig. 14—External forces acting on a front-wheel drive vehicle negotiating a turn, with excess torque on the driving wheels

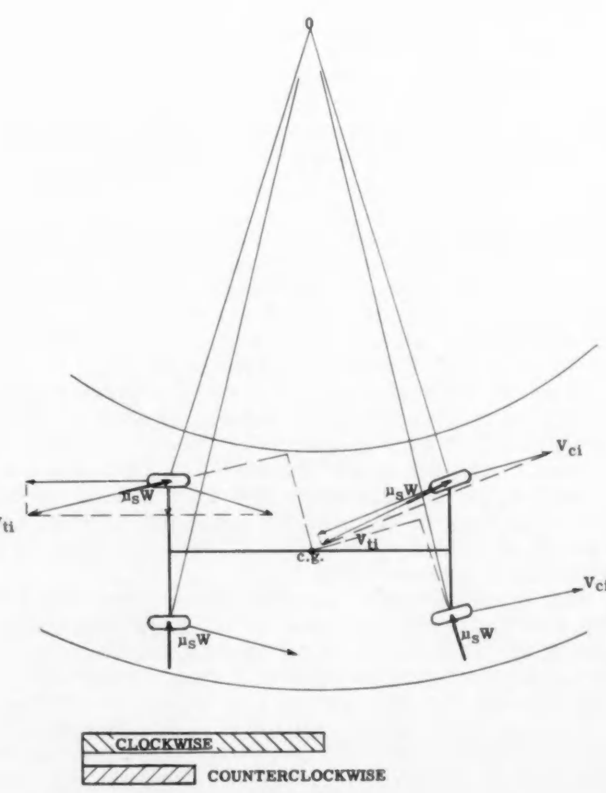


Fig. 15—External forces acting on a four-wheel drive vehicle negotiating a turn, with excess torque on the driving wheels

EXCERPTS FROM PAPER* BY

T. P. Wright, Vice-President, Research, Cornell University

* Paper, "Research and Development to Promote Safety in Aviation," was presented at the SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950. This paper will be printed in full in SAE Quarterly Transactions.

How to Increase Safety in Scheduled Air Operations

FIRST, consideration will be given to those factors that are designed to prevent accidents. Later, the factors which contribute to assurance of the survival of aircraft occupants in the event an accident occurs will be treated.

1. The Aircraft.

a. *Structure*—The accident record indicates remarkable integrity of structure of aircraft, so that the principal need is for continuing development derived from existing research coupled with continuation of the research effort on the basis that is now underway. Such matters as load factors, design criteria, and special problems of structural analysis have been well worked out, and we can count on production of satisfactory structures by continuation of existing programs. Detailed design needs constant watching in order to assure that sound engineering practices prevail. Such matters as use of adequate fillets, care in checking for load carry through and adequate consideration of stress concentrations are important.

In our constant striving for greater structural efficiency, new materials will be sought for and evaluated, bringing up many problems in each case. From the standpoint of safety, emphasis must be given to the necessity for complete appraisal of all properties of each new material. We recall the experience in making the transition from 24S aluminum alloy to 75S. Increased yield strength of the latter material led to weight saving through smaller scantling sizes without due regard to the fact that the endurance limit of the material was not commensurately greater. This led to premature fatigue failures, in certain instances with disastrous results.

More emphasis needs to be placed on fatigue. We know that after a certain number of cycles of stress reversal under given conditions of load variation, failure will occur. However, we have no means of determining by inspection at just what stage in the stressing a structure has arrived. Thus, in a sense, all fatigue failures come as a surprise. Very extensive research is under way to explore this matter in the hope that some method can be discovered to determine how near at any period of service the material may be to a fatigue failure.

One consideration that requires both research and development is gust alleviation. The design criteria for the sustaining surfaces of the aircraft are based upon gust loads. We need evermore information on the nature of gusts, to be followed by determination of adequate means of alleviating the imposed loads. A. E. Russell has discussed the substantial weight saving achieved in the Brabazon aircraft by the adoption of the gust alleviation means. There have recently been developed transfer valves capable of action at such high speed that they can transfer the impulse from a sensing vane into actuation of mechanism to deflect the flaps and elevator so as to counteract the effect on the structure by the gust. Other means are being developed, such as automatic relief from gust loads incident to the parallel deflection of ailerons.

Another field requiring increased emphasis involves the overloading that may be caused by exceeding placarded speed limits. Unfortunately, in our high-speed aircraft, the normal cruising speeds are so close to the critical speed that atmospheric conditions or entry into a letdown too rapidly may bring this situation about. Work is underway on this problem and of automatic speed control means for obviating the difficulty.

b. *Powerplant*—Great credit must be given to our powerplant designers for the remarkable reliability that the modern aircraft-engine possesses. In air carrier operations, the added reliability of multi-engine arrangements makes failure of powerplants a relatively small cause of accidents.

However, there is need for continuing improvement in systems design, including the fuel, oil, electrical, and hydraulic installations. Reduction in complication and introduction of automatic devices, although usually troublesome when first placed in service, in the ultimate add to safety.

Possibly the single item needing the greatest

amount of research and development attention is the propeller. Appreciation of the advantages of the turboprop combination leads one to believe that the propeller will be of importance for air carrier operations for a long time. Presently we have problems of de-icing and anti-icing, which are quite well solved but can be improved. Generally, dependability of the propeller in connection with the systems involved in automatic feathering and in pitch reversal is still questioned, and is of extreme importance because of the dependence that present rules give to automatic feathering in connection with take-off under transport category rules in the former case, and the dependence on the propeller as a braking means in the latter.

c. *Aerodynamics*—From the standpoint of safety, again we may consider ourselves fortunate in having transport aircraft of such excellence aerodynamically. Normal development should be satisfactory in determining any small improvements necessary in new aircraft configurations involving problems of stability and controlability. There have been quite a few accidents involving what appeared to be inadequate stall characteristics or control at stall, sufficient at least to require watchfulness in this regard. Possibly our greatest concern in the field of aerodynamics is that dealing with situations arising through higher aircraft speeds and the close approximation of these to the critical speed where drag rise and compressibility are approached.

d. *Operational Considerations*—A major consideration in this area is icing. There is need for additional understanding of the thermodynamics of ice formation. Fortunately, in the field of anti-icing great progress has been made, particularly in connection with the wings, where the work of the NACA has demonstrated the practicability of thermal anti-icing. Designers of aircraft developed to use this system have had their difficulties in connection with heat interchanges so that exhaust gas source could be used indirectly, obviating the corrosion difficulties that direct use imply. Problems of preventing ice formation in the carburetor are well understood and, of course, are eliminated entirely by the use of the fuel injection system. Recent technical papers have shown that rotor icing problems must be solved in the case of gas turbine engines.

De-icing systems are less frequently utilized in new aircraft, but should be continued in development because of the possibility that in high-speed aircraft a dual system employing both heat anti-icing and mechanical de-icing will be required.

Although fire in flight is relatively an infrequent occurrence, nevertheless the implications are of such a catastrophic nature that it represents possibly the number one item requiring attention from the standpoint of public confidence. Because of the findings of the special committee on air safety appointed by the President in 1947, the NACA has formed a special committee to consider the whole matter of fire. In addition to this, a tremendous amount of work has been accomplished by the development center of the CAA at Indianapolis, where a wind tunnel for the study of powerplant fires has been in operation for several years, and where catapult equipment for studying fuel tanks and other parts of the system involving fire in the event of crash are available.

In connection with prevention, continuing studies of the design of fuel and oil lines and couplings are important. As vibration is a fundamental cause of failure in such lines, much work is being done in this regard. Development of engine roughness indicators is also of importance, so that pilot action can be taken immediately when undue roughness develops. The record indicates that minor fires in the electrical system are more frequent than is generally supposed and, as any minor smoldering may develop into a fire, it is possibly in this field that the greatest attention should be given.

A tremendous amount of work has been done in the field of safety fuels and fluids. It seems to me unlikely that we will develop a real safety fuel of practicable use for reciprocating engines, although we may be more optimistic as regards gas turbine engine. Better results have been obtained in the matter of hydraulic fluids.

I would like to draw attention to the potential benefits of an inerting system for fuel tanks, compartments, and nacelles. The essentials are the use of the exhaust gas, suitably cooled for introduction into the air space above the fuel level so as to create an atmosphere in which combustion will not be supported. It is believed important that the research work be extended in application to the wing compartment surrounding the fuel tank and to the nacelles.

Another possibility for enhancing safety from the standpoint of fire is the location of all of the fuel in wing tip tanks where the range requirements of the aircraft will permit. Preliminary studies of the Convair Airliner have indicated that in this case the scheme is practicable, although more thorough analyses are required. Such installation would permit ready dropping of the fuel tank in the event of emergency and would, of course, always place the main source of fuel for fire at the farthest point from the occupied compartments of the aircraft.

Generally speaking, we have not been very successful so far in developing a reliable fire warning or detection device. Recent research in the photoelectric system appears promising.

Extensive data are available on the locations, particularly in the engine compartments, where fires may start, and satisfactory specifications have been developed to locate fireproof bulkheads to obviate spread from one compartment to another. The greater use of stainless steel in the nacelle structure appears to be indicated.

For many years CO_2 has been used as a fire extinguishing agent. Recent research indicates far better results may be anticipated from methyl bromide, which, in addition to the smothering action, enters into the molecular structure of flame propagation, inhibiting fire.

An operational problem of major importance three or four years ago had to do with take-off and landing with relation to runway length and a number of variables affecting adherence to the regulations. In the transport category it is required that an aircraft have the ability either to continue flight or to come to a braked stop within the length of the runway area in the event of an engine failure. The variables involved are the take-off weight, runway gradient, temperature, airport altitude, and wind. In 1947, a number of accidents, some of major mag-

nitude, brought about a careful study of these variables, with the result that it became obvious that each must be given appropriate consideration in determining whether or not a given runway would be adequate for a given aircraft in a specified weight condition. The President's special committee for inquiring into aircraft accidents called many witnesses to consider this matter and, as a result, a cooperative job was undertaken in which the airlines, Airline Pilots Association, the CAA, and the CAB participated. This resulted in determining for each runway in the country and for each aircraft what weights for take-off could be tolerated under different conditions of the variables mentioned. It is believed that the research necessary to determine the effect of these variables has been well established, so that the present conditions are adequate, requiring, however, special investigation for new aircraft as they are developed.

It is also believed that continuing research, and particularly development should be undertaken in connection with the apparent advantages from the standpoint of safety of the use of the cross-wind landing gear on transport aircraft. Aircraft so equipped have a wider range of runway selection possibilities, thus making practicable more frequently the use of the longest runway at a given field even though located at a substantially greater angle to the wind.

An operational hazard which has received a great deal of attention by the CAA is bird strike. There are over 400 per year. As speeds become higher, the effect of birds striking the windshield becomes more and more serious and may be catastrophic under certain conditions. The CAA research and windshield testing program has resulted in a great amount of information, usable in the design of windshields that will withstand bird strikes successfully. Thickness of the plastic layer between laminations of glass appears to be of importance.

Consideration must also be given to eliminating this hazard from the standpoint of carburetor air intake, lights, and other vulnerable parts.

It appears appropriate to include a brief discussion on the much debated item, accelerated service test. The philosophy underlying the need for a considerable period of service testing involves categories of failure which the test is aimed to discover and rectify prior to placing a new aircraft in passenger-carrying operations.

The first category involves detail failures due to design errors and personnel adjustment. These are listed together as they both will presumably occur in larger numbers at the beginning of a test period and gradually reduce as more and more flying transpires and corrections are made.

The second category involves failure by fatigue and failures due to maintenance difficulties. In this instance the curve of failure as ordinate against time as abscissa will have the opposite shape, starting out with practically no failures and over a long period of time gradually increasing.

A final category of failures must be listed as unpredictable, showing a more or less straight horizontal line on a plot such as the above, with wavy variations as time progresses.

In preparing a combined graph of these categories, properly weighted for the number that will occur based on experience, it appears that the slope will be downward to the right with substantially more at first, up to a certain point, at which the slope is very slight or the line becomes horizontal with slow rise after a very great amount of service. Poisson's exponential series is sometimes used in obtaining a solution for problems relating to random events. Jerome Lederer, director of the Flight Safety Foundation, has suggested the applicability of Poisson's distribution method in obtaining this combined graph. The point at issue, then, is to determine what is a reasonable time of flying before the first transition from downward slope to near horizontal takes place.

Military experience indicated that a very large number of detail failures would be eliminated by conducting a 150-hr accelerated service test. For a transport aircraft developed at this time, it appears that the designing firm may carry out about 400 hr of testing, conducted under very careful engineering surveillance. There will then be a test period of 150 hr or less conducted by virtue of CAA regulatory requirements after the designer has completed his work. There will then be possibly another 150 hr of testing by the airline initiated because of regulatory requirements plus its own needs. Thus, a total of 700 hr of flying before passengers are carried may be involved. Is this enough? Many feel that a much longer period of testing is required in order to bring to light and remedy types of failure that will only occur after a great deal of additional time. The suggestion has been made that if the federal government approves legislation under the heading "Proto-

PRESENTED here is an analysis of the factors needing research and development to improve safety in scheduled air carrier operations.

The author discusses these factors in terms of:

1. The aircraft — which involves all branches of engineering needed to develop aircraft design so as to assure the minimum possibility of failure of any of its myriads of components.

2. The atmosphere—which involves meteorology and the air and ground aids necessary to assure schedule completion safely under any of the variations that nature presents.

3. A man — which involves human engineering, with increasing emphasis on physiology, psychology, sociology, and all other sciences that have man as a common denominator.

In the complete paper, the author also covers the subject for commercial services and for personal flying.

type Development," then a considerably larger amount of testing before placing in service would be practicable, which is not economically feasible at the present time from either the standpoint of the manufacturer or the airline. Another alternative is to place a newly developed plane in freight-carrying service for a year or so prior to placing in passenger service. Difficulties can be foreseen in this scheme also, and possibly the best arrangement is to place a newly developed transport plane in military service on MATS, where larger risks are acceptable. My own view is that the amount of testing that a new model normally gets (700–800 hr), as indicated above, is adequate to determine types of error or failure that will result in serious accidents, assuming especially careful inspection surveillance during the first subsequent year of scheduled service. The record in certain instances, possibly, does not bear out this optimism, but from the standpoint of economics and practicable alternatives, it is believed we can proceed on this basis with reasonable assurance of safe operation.

2. The Atmosphere.

a. *Turbulence*—There is need for additional research to determine the structure of the atmosphere and the causes of turbulence, particularly that type known as the clear air bump. Having determined the structure of the atmosphere and the need for avoidance, the next step is to make possible detection of areas that should be avoided. Although a great deal has been done in the field of radar detection, it is believed that these studies should be intensified in order that the pilot may be assured as to what he might encounter sufficiently in advance to permit avoidance. Gust alleviation might reduce this need, but will not obviate it.

b. *Lightning*—Transport aircraft have returned from flights where lightning has been encountered. In a great many cases the only damage that could be detected was a small hole burned in some surface, a burned-out antenna wire, or some other such indication. It has not been felt that lightning in the modern all-metal airplane could be considered a catastrophic hazard. However, there are instances where uncertainty exists and where disastrous results appeared to be susceptible of no other explanation. Therefore, it appears appropriate that continued research be conducted under varying conditions to bring to light new information on this subject. If any unexplained fires have been occasioned by lightning, it should be noted that the inerting of the gas tank or its compartment should be useful as a fire-prevention measure.

c. *Low Visibility*—Short-range weather forecasting from the standpoint of supply of reliable advice and exact visibility conditions is extremely difficult. Many controversies have raged regarding the visibility conditions as reported from the ground but as observed far differently from the air. This is to be expected, and efforts have been made to determine just what should be the relative responsibilities between the airport tower operator and the pilot in such instances. The pilot may declare an emergency condition at any time, which, it seems to me, might be interpreted to include observations that he makes which differ from those given from the ground station. This would permit him to land under such emergency condition where he himself sees it is practicable, thus enhancing safety by obviating certain hazards that may exist in continuing to his first alternate airport. Pilots, however, are extremely reluctant to declare such emergency on the basis that there is a certain stigma implied by this action, and that they are required to make lengthy explanations to CAA personnel. This is a matter of human and company-government relationships that should be ironed out to assure adoption of optimum procedures for safety for the aircraft and its occupants.

The need for development of airborne radar equipment to permit detection of obstacles under low visibility conditions is obvious, and a great deal of work has been done.

There are two pieces of equipment that are much needed and should be developed to an accuracy that will assure reliability. These are the terrain proximity indicator or radio altimeter and a collision warning device.

d. *Air Navigation Aids*—Our chief reliance for safe flight in inclement weather for the present must rest on electronic air navigation aids. In 1947, the Radio Technical Committee for Aeronautics developed its famous SC31 report, which determined an interim program for air navigational and landing aids and established certain criteria which should be met in order to permit development of a system known as the "ultimate." This involved the determination of operating conditions 15 years hence, in order to assure that a system now conceived would still be usable at that time under conditions of aircraft, airports, and other variables that would then exist. The task of carrying on these investigations and of supervising the intermediate program through CAA was assigned to the Air Navigation and Development Board.

The basic system for air navigation aids for the intermediate period is essentially the one adopted by CAA prior to the publication of SC31. This is the so-called RO (radius-azimuth) system employing the VHF omnidirectional range, coupled with distance measuring equipment (DME). With the information from this system, coupled with altimeter reading, the position of the plane in space with reference to one known range station is determined. Assuming a network of stations throughout the country, the plane using this system can fly any course over stations and, with the availability of a parallel course computor, any course at all. Installation of this equipment is well along, and its complete establishment will mark another step forward in the very fine navigational aid conceptions initiated by the CAA. For flight under less restrictive visibility conditions, the system includes airway lighting and intermediate emergency fields, now, however, considered of very little importance from the standpoint of scheduled air carrier operations.

e. *Communications*—interchange of information and knowledge of position of aircraft is required on the ground. Hence, a VHF radio communication system has been made available. Ground information, of course, is only accurate to the extent that the pilot correctly determines his own position in space. Problems are involved in the suitable presentation of information to ground stations, which is intimately connected with the problems later discussed under air traffic control.

f. *Procedures*—The President's Special Board of Inquiry spent a great deal of time on the establishment of suitable route patterns, with particular references to required elevations of flight. The cooperative program conducted by the airlines with the CAA and the CAB established route minimum altitudes and approach minimum altitudes which has been an important factor in continuing the improvement of our very fine airline safety record during the past three years.

g. *Instrument Landing Aids*—The basic landing aid of the Federal Airways is the instrument landing system (ILS), which is now available at all of the larger airports. Installations are continuing to be made.

Supplementing ILS and forming a part of the system on airports of maximum density is the ground control approach (GCA).

This system has permitted reduction, with accompanying enhanced safety, of airport minimums from 400 or 500 ft and one mile to 300 ft and three-quarters mile (or, in many instances, to 200 ft and one-half mile).

A fully automatic monitoring system is now being developed. It should be noted that this system permits a direct coupling between the ILS instrument and the automatic pilot to make possible completely automatic landing, of potential importance as a step toward operation under zero-zero conditions.

h. *Air Traffic Control*—The largest problem confronting the ANDB is air traffic control under anticipated conditions of greatly increased traffic, particularly at large terminal areas. The problem involves automatic recording of aircraft position and automatic instruction as to the course to follow. Block systems are implied. At present this function is carried out by the airway traffic control officer, passed over at approach to the tower operator, his chief assisting tool being surveillance radar (with normal VHF radio communications).

Only a given number of arrivals or departures can be accepted on a given runway under instrument weather conditions. This number of acceptances is substantially less than under clear weather conditions, so that control from departure points, as well as holding patterns, may become necessary. Elimination or reduction of the stacking problem is, therefore, associated with this whole matter of air traffic control. At larger centers of population, and with public preference for certain hours for arrival and departure, it is obvious that the problem is a big one. Whereas clear weather arrivals and departure can safely be conducted at one-half minute intervals, at present three minutes or slightly more are all that can be tolerated under instrument conditions, with two-minute intervals having been accomplished in certain instances. A first ANDB objective is one and a half minutes, with likelihood of reducing the time to one minute eventually.

i. *Airports*—From the standpoint of scheduled air carrier operations, a problem that must be confronted is the specification of each airport for only certain types of traffic. This segregation of traffic will be based on aircraft characteristics and/or type of flying. Aircraft whose approach speeds are reasonably similar should be the only ones permitted on certain airports where passenger carrying is involved.

3. The Human Factor.

a. *Relation of Man to Machine*—Man is a complex servomechanism of relatively high efficiency. Like

Statistics Show Need for Improvement

"BEFORE getting into the real problems confronting us," T. P. Wright says, "it is well to see what progress has been made so as to find where greatest need exists and therefore where greatest emphasis should be placed. The conventional yardstick in air transport operations has been passenger fatalities per 100,000,000 passenger-miles travelled. Averaging over 5-year periods from 1930 for the domestic scheduled airlines, the figures are: 15, 6.1, 2.4, and 1.8, winding up last year at 1.3. This shows good progress. (The record of over-ocean flying is phenomenal—better than surface vessels—and was perfect in 1949.)

"Safety statistics for nonscheduled air carrier operations are not so encouraging. One would expect a lower level of maintenance where an irregular service (as to schedule or points served) is involved. By the same token, pilot familiarity with the route traversed is less and ground organization inferior, with company communications less or absent. The greater variation in aircraft used makes extremely difficult the job of the Government authorities in establishing requirements for aircraft, crew, and operations that will equal in safety potential those of the scheduled air carriers and at the same time permit development (by use) to continue in this area. Also, problems of inspection and enforcement are less certain. But certainly continuous improvement can be achieved.

"In the field of personal flying, the safety record either in absolute or relative terms is unsatisafctory. Even when searching for trends of improvement through the years we are disappointed . . . it appears that personal flying is less than one-thirtieth as safe as scheduled air carrier operations.

"I feel sure that scheduled air transportation is going to continue its steady growth and improvement in economic stability, with an attendant ever-improving safety record. For any wide acceptance of personal flying, however, a vast improvement in safety is essential."

any servomechanism he is organized for sensing, interpreting, commanding, and acting. In order that these processes may be carried out accurately and quickly, a number of considerations must be analyzed.

One of these, as related to the pilot, is his environment—the cockpit. He must, properly to carry out his task, be afforded a relatively high degree of comfort, which means freedom from noise and vibration; from large variations of temperature; and with proper ventilation, including cabin pressurization at altitudes above some minimum, together with availability of supply of oxygen. His seat must be comfortable, which means adjustability in all directions. Unless such degree of comfort is provided, it may be assumed that fatigue will take place so as gradually to impair his efficiency, particularly in the face of an emergency situation. Research into the quantitative factors governed by effects of fatigue is important.

Another factor requiring more study is the determination of the maximum allowable degree of complexity which one man can tolerate without reduction in efficiency. An important study that has received a great deal of attention in the past few years, is instrumentation and instrument dial display.

Another very interesting study deals with the eye motion of the pilot during an instrument landing system letdown. Accurate measurements were taken on a large number of pilots, including length of time that each instrument was viewed; the number of times each instrument was viewed per minute; and the overall percentage of time that each instrument was studied. The analysis showed the need for locating instruments so that those most used will be in best view. Linkage values in passing from one instrument to another were also studied in order to determine the best location of each instrument with relation to others so as to reduce the time to a minimum.

Once all of these types of problems are solved to best advantage, a final study should be made of cockpit standardization. To my own knowledge, cockpit standardization has received attention for the past 30 years. Real implementation of findings is what now is needed. Certainly, great advantages from the standpoint of safety, particularly with equipment interchange growing, would result from standardization of the cockpit, scientifically determined as to arrangement of the various components.

b. *Man to Man*—A number of problems are involved here, of which the following are cited as examples.

A proper balance between regulation and education is essential. There is always a tendency for the advocates of one or the other to go too far without appreciating the need for both.

The establishment of techniques in pilot training and in the determination of pilot proficiency is important. CAA sponsored studies established that the proficiency rating system developed is substantially more reliable than the inspector-judgment system which has prevailed.

Another problem has to do with the determination of approximate crew complements, when degree of complication becomes such that the pilot and copilot have to deal with conditions, particularly in emergency, greater than can reasonably be expected. Under such a situation, a third man, the flight engineer, must become part of the crew. Ascertaining the degree of complexibility which warrants the third man must be based on scientific determination of the line of demarcation between needed relief from an arduous job as against what may inherently be a dangerous factor in having one more person in the way and causing interference.

One factor that is mentioned frequently and needs more study in relation to aviation is the indefinite term "accident proneness." It seems really to exist, but of its nature we know little.

A final problem in this area is the determination of policies by aircraft manufacturers and airline executives directed to organization, such that safety is emphasized. In more and more companies, the position of "director of safety" has been created with view to placing on one man the responsibility of viewing the aircraft design, pilot, and other personnel relationship, inspection and maintenance procedures, and all other factors from the sole view of safety, regardless of economic or other considerations. His superior will then be in a position properly to compromise between factors, all of which will have been brought to his attention forcefully from the particular point of view of those having cognizance in several areas.

Survival

The proportion of fatalities to injuries in aviation is high. Some have placed it at 50 times as great as in automobile and railroad transportation. This, of course, tends to dramatize aircraft accidents so that each one makes the headlines. Therefore, in addition to the obvious desire of all to reduce the cost in lives, it is of the utmost importance to the airlines economically to reduce fatalities to a minimum. In studying this problem there are two main factors involved, one is to assure that fatality does not occur due to impact with the ground, and the second is that, having survived this impact, fire or other circumstance does not creat fatality.

Impact Fatalities—Analysis of several accidents, where information could be obtained, has shown that passengers were either killed or so incapacitated, or otherwise so thrown about, as to make it unlikely they could find their way out of the airplane within sufficient time to avoid a fire which might later commence. First attention, therefore, must be given to conservation of the passenger's life and ability to move around under his own power after the first impact. Designed to make this possible is the safety belt, which, the record indicates, has been almost completely inadequate for the purpose. Analysis of information available leads me unequivocally to endorse an immediate change in regulations which requires a safety belt strength for passengers of 20 G to include the carry-through system from the belt to a main structural member. For forward-facing seats, another requirement is that the back of the seat be designed, including the use of sheet material suitably padded, so that head injury will not result from forward impact against it. An alternative is to use backward-facing seats designed to withstand a forward (aircraft) impact of 20 G with suitable follow-through.

For the flight crew, a must is to provide seat belt and shoulder harness so designed as to withstand a forward G of 25. In this instance, the use of the inertia reel type of shoulder harness will provide adequate movement to perform comfortably all of the functions required.

Fire after Impact—We have available much information in connection with possibilities of reducing the number of disastrous fires after crashes. For one thing, it appears that the record of after-accident fires has been far better in the U.K. than in this country. One factor that is receiving much attention is the automatic impact shut-off switch. This has been a requirement in the U.K. and may be one of the factors which has contributed toward the lower percentage of fires in that country.

A second point of attack on the problem is the fuel tank. It appears that approximation of a crashproof installation would be important in reducing disastrous after-crash fires. It is believed important in this regard to consider the inerting system.

Another design innovation is the storage of fuel in wing-tip tanks. Here it is obvious that ability to drop the tank prior to an impending crash landing would practically eliminate a large source of fuel for the fire and, even if the tank were still on the aircraft when it struck, any resulting fire from spilled gasoline would be at the maximum distance from the passenger compartment.

Another factor which is receiving attention is the automatic release of fire extinguishers, located most advantageously to perform their function.

A final item needing additional attention is the location of cabin exits. Best information available indicates that an optimum arrangement of locating exits is one for each eight passengers on alternate sides of the cabin and properly proportioned in size and in detailed location to permit ready egress.

Survival after Water Landings—A tremendous amount of study on this subject was given during World War II. The design of equipment such as Mae Wests, rafts, emergency radio, and also ditching and escape procedures, as well as training and briefing, was perfected to a high degree. Fortunately, our recent record for over-ocean travel with land planes is extremely good. This excellent record should not lull us into elimination of development of equipment; of carrying it on all trips; and of following out briefing procedures.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Vehicle Drive Stability

Continued from Page 34

the plane of the wheels, as in the other two cases. At the instant the wheels begin to spin, these forces decrease from u_r W to u_s W; the direction of their action is dependent on the relative motion of the tire with respect to the surface, V_{tt}. However, the summation of moments about the center of gravity is more nearly equal to zero than in the other two cases.

The vehicle will move parallel to itself in a direction which is the resultant of the tangential and radial velocity of the center of gravity. This will continue until the curvature of the vehicle path is reduced. On ice, with a locked center differential and the application of excess torque, which forced the wheels on each axle to spin simultaneously, it was difficult to throw a truck with all four wheels driving into a flat spin.

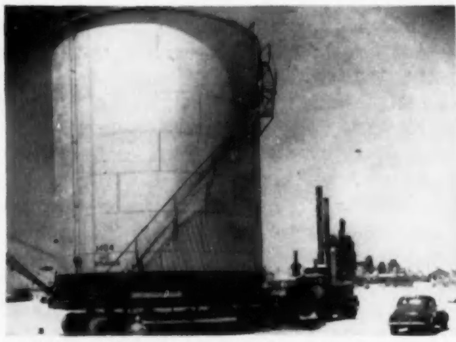
From a practical standpoint, especially on curves, it is desirable to have the sum of the moments of the forces acting on the vehicle as low as possible. If a stable vehicle is defined as that vehicle which has zero moments acting on it in a horizontal plane, then the front wheel drive is unstable in a clockwise direction, which causes it to hold its course on a straightaway, but to go off a curve on a tangent to that curve. The rear drive is unstable in a counter-clockwise direction causing it to go into a flat spin either on the straightaway, or on a curve. The four wheel drive in each case has a relatively small net moment in the clockwise direction. This makes it hold to its course on the straightaway, but is not so large as to throw it off a curve on a tangent to that curve.

Little has been said of load distribution. Within reasonable limits it enters into these considerations only as it affects the ability of the vehicle powerplant to spin the driving wheels.

For example, of two identical rear drive vehicles, the vehicle that has the greater per cent of the load on the driving wheels is least apt to skid on an ice surface. If the center of gravity is moved to the rear, the normal forces at the rear wheels are increased; but the moment arms about the center of gravity are decreased a corresponding amount so that the net moment remains very nearly the same.

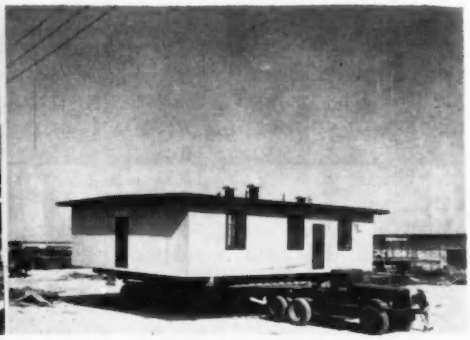
The paper also discusses drawbar pull tests conducted on ice and evaluates the traction and gradeability of the three drive types.

(This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)



This is only one of several such tanks moved. The heaviest tank weighed 75 tons, was 45 ft in diameter and 45 ft high. The rig here consists of a special two-dolly trailer and a Kenworth 6 × 6 tractor truck

Vehicle mobility over sand depends largely on tire design. Shown here are 36.00 × 40, 32-ply tires on axles before being mounted under a rig for hauling equipment



Hauling prefabricated houses over sand is no unusual feat in desert trucking operations. The house measures 32 × 42 ft and weighs about 50 tons. This one is being carried on a special two-dolly trailer

DESERT - DEFYING

EXCERPTS FROM PAPER* BY

Richard C. Kerr, Arabian American Oil Co.

* Paper "Automotive Transportation in Saudi Arabia," was presented at SAE National Transportation Meeting, New York, Oct. 16, 1950.

SAUDI Arabia's sand and heat exact severe demands in mobility and engine cooling from vehicles operated by the Arabian American Oil Co.

Without special sand tires, all-wheel drive, and excess engine power, vehicles carrying 100 ton and higher loads would bog down before getting started. Desert vehicles also must be equipped with oversize heat dissipation, equipment, and controls. This is cheap insurance against the high cost of operational delays, equipment damage, and injury to personnel stemming from absence of these items.

During the 17 years of this operation, the following features have become fundamental to acceptable off-road mobility:

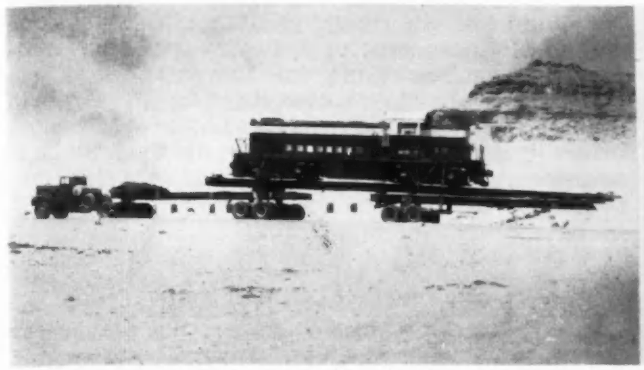
1. Off-road tires operated at low inflation pressures for all vehicles.
2. All-wheel drive in all classes except light cars.
3. More than average engine power for all vehicles.
4. Low speed axle gear ratios for all vehicles.
5. Main and auxiliary transmissions with low ranges and top direct for all trucks.
6. Power steering on the larger trucks.
7. Compressed air available for tire inflation on the larger trucks.

Preliminary testing and engineering studies indicate that adoption of fluid couplings, torque converters, automatic transmissions and semi-automatic planetary type transmissions will undoubtedly be the next logical step in the improvement of the vehicles. Diesel engines offer certain advantages that are certain to be tested. These features have not, however, been used extensively to date. Despite the apparently radical departures in design that have been finally adopted, they have only been actually accepted after a relatively slow and conservative approach.

The operations are too far from home and too vital to the entire project to risk acceptance of any radical departure that might develop bugs under the rigorous conditions of desert operation. Step by step the designs have been tested under actual working conditions and progress in the future will probably be accomplished by the same procedure.

Sand mobility is stressed here. But it has been demonstrated that the so-called sand tire, or the more properly called off-road tire, also possesses superior mobility in mud, soft soils, and snow, and exhibits unexpected resistance to rock bruising. They are easy on the roads, minimizing road maintenance, and the cushioning effect of the tire materially reduces vehicle maintenance.

These tires differ from the standard highway type tire. They are much larger in cross-sectional diameter, larger in overall diameter, have much thinner and more flexible side wall construction, much thinner tread stock, a subdued tread pattern, and have a round tread profile instead of the customary



This 125-ton locomotive is on a cradle, with rails on the cradle. It was moved 50 miles overland in 6 hr, with a Kenworth tractor in front and the same type truck pushing behind. The rear cradle extension permits the locomotive to run off on its own wheels to a railway siding. Pullman cars also are hauled this way

From Ras Tanura to Abqaiq, a distance of about 100 miles, was the trip made by the Kenworth 6×6 tractor and Eidal dolly in hauling this 50-ton horizontal gas trap. This same tractor and trailer has moved about 15 such vessels. Line pipe loads, almost as heavy as this one, are also all in a day's work

DESIGN CHANGES

Keep Arabian Oil Fleet Rolling By Vanquishing Heat and Sand

angular profile with heavy shoulder buttress and block.

The emphasis is on flexibility and the ability to operate without serious damage at low inflation pressure with consequent high deflection or wide bulge. The tire must present a large flat area of rubber to the ground with the lowest practicable unit ground bearing pressure.

The ideal sand tire would be one in which the thin flexible side wall would continue right across the tread area, from bead to bead, without any tread stock or tread pattern whatever. This is, of course, impractical. Such a tire would wear out in the tread area immediately and would have little resistance to punctures and rock bruises. We are forced to design the tire with sufficient tread stock and tread thickness to give us reasonable tire life.

Similarly we are limited in the reduction in air pressure we can use. To support a given load at a given speed with low air pressure, we must design the tire with much larger cross-sectional diameter, larger overall diameter, and thinner side walls than the highway tire.

There are, however, definite practical limits. We cannot use gigantic balloons because of interference with the vehicle frame and the necessity of keeping the vehicle bed height within reasonable limits. These size restrictions force us to use optimum inflation pressures. The selected air pressure governs the number of ply that must be used in the carcass to prevent rupture or blow out.

These demands circumscribe the final tire designs. The tires finally developed have been compromises between our desire for unrestricted mobility and the necessity of adapting the tire to a practical vehicle.

We have developed tires that will permit our vehicles to traverse level sands with ease and will permit the vehicles to climb sand slopes of 30% in low gear ranges at slow speed.

The selected performance enables us to carry on our normal work and to traverse all ordinary desert trails at sufficient speed to meet our demands.

To design for greater mobility and speed is far too costly an undertaking. The principles involved are well known and we can, if we wish, design for greater mobility. We have actually done so for a few special vehicles. The values of rolling resistance and tractive effort for the various type tires are known with sufficient accuracy to predict sand performance, and sand gradeability to reasonably close limits.

Sand Demands All-Wheel Drive

Second only to the use of the off-road tire in promoting sand mobility is the adoption of all-wheel drive. Only the light-car class sedan and pickup types have survived as rear wheel drive units in

sand terrain. They have been able to do so only because of the skill and training of the desert-wise driver and because of their relatively great power, speed, maneuverability, and flexibility.

These light cars rush the soft sand areas and frequently carry through by momentum. But even in the hands of the most skilled driver they do get stuck, and unassisted extraction is always time consuming, exceedingly laborious, and very frequently impossible. The vehicles are exceptionally useful and are popular because they provide rapid, comfortable transportation. Their use over well-travelled routes is approved. Even if the vehicle does become stuck, the trucks using the same route can be depended upon to extricate it.

All-wheel drive is imperative in the truck class vehicles. They cannot depend on speed or maneuverability. They must be able to keep moving. In fact, they must be able to do so with ease and at fair speed, unless the traverse be impractically time-consuming.

The truly marvelous performance of these vehicles can only be appreciated when compared side by side with the normal highway type vehicle. The casual observer viewing a convoy of heavy trucks and light cars moving rapidly and with apparent ease through the sand dunes is apt to assume that it is not a difficult performance. It requires a spectacular demonstration to bring out the true comparison.

The show must be staged to do so because the normal highway type vehicle cannot even cross the level sand stretches to get to the dunes. The best-staged demonstration is to start both vehicles on hard ground, cross a level sand approach, and climb a sand slope. Invariably the highway type vehicle becomes hopelessly stuck immediately upon entering the level sand, while the off-road vehicle moves rapidly across the approach and proceeds without difficulty up the slope.

Frequently the stalled vehicle cannot even be towed successfully through such sand. The idling front wheels dig in so deeply that the wheels stop turning and become a very effective deadman. Applying power to the rear wheels only scoops out the sand until the axles drag. The best remedy is to unload the vehicle, pick up the front end with one of the off-road wreckers, let the air out of the rear tires until they bulge, and then take it away without assistance from its own driving wheels.

All-wheel drive equipment is expensive and transfer case, front drive line, and driving front axle require maintenance. But any other solution is more costly. It is impractical to construct hard road everywhere; the use of track layers is too slow and costly; and no other solution is presently apparent.

The most pressing need is to provide flexibility to the drive that will obviate the necessity of declutching the front-wheel drive when operating on hard surfaces, but that will not permit the front or rear drives to spin free on slippery surfaces and thus rob the wheels that rest on good traction surfaces. Center differentials of the ordinary type accomplish the first requirement; but they must be used with a hand lock when operating on slippery surfaces. Serious stress is thrown into the entire power transmission system of any hand lock type if the driver fails to release the hand lock when hard surfaces are traversed.

Automatic self-locking differentials possibly offer a solution. Independent engines for the front and rear axles have been considered. Parallel fluid coupling or torque converter drives from the same engine with automatic or planetary type semi-automatic transmissions may be the solution. These solutions have not yet been tried in the Arabian operations. So far the emphasis has been placed on driver training and acceptance of the resulting maintenance costs as being the least expensive expedient.

More Power for Less Gear Shifting

Power is perhaps third in importance among the factors influencing mobility. Power is not desired for the purpose of increasing the hard surface speed of the vehicle. For many reasons it is necessary to govern all vehicles to a very moderate top speed.

Power is desired to increase the overall steady average cross-country speed by providing a high degree of flexibility with less frequent gear shifting, less frequent stalling, and higher sustained speeds against the heavy drag of the sand. Splitting gears in particular is a very difficult operation. Few drivers have mastered the technique of simultaneously shifting both gear boxes.

Pulling through sand, even with sand tires, is much the same as long mountain grade climbing. The rolling resistance of the tire in sand is from 4 to 10 times as high as the rolling resistance of hard tires on a hard road, and maintenance of reasonable speed requires adequate horsepower. The governed speeds shown in Table 1 are recommended.

Even the moderate speeds are frequently too fast for the exceedingly rough desert trails. But compromise must be made between vehicle maintenance and the demands of the job. The horsepower indicated exceeds that required for the top speed limit on hard surfaces, but is needed for the sand terrain speed desired.

Axle gear ratios are selected to permit the engine to be governed to the manufacturers recommended top speed, and still keep the vehicle to the desired road speed, with the main and auxiliary transmissions in top direct drive. Therefore, the selected ratios are much lower than for high-speed highway operation.

These low gear selections permit limitation of road speed without governing the engine to undesirable and inflexible slow speed. When used with the excess power engines, they permit the vehicle to proceed at relatively high speeds through the sand without excessive main transmission manipulation.

The truck class vehicles are all equipped with four-speed main transmissions. The 12-ton class vehicles have three-speed auxiliaries and all other two-speed transfer cases. In all cases top speed is direct. In each case the lower ranges have been selected primarily for optimum progression with split gears. The final low range is however in all cases somewhat lower than normal highway practice.

Flexibility is desired as much as low range. The excess engine power delivers about all the torque the axles should be called upon to endure in the

lower ranges and further reduction is not contemplated.

In a few special 30-ton class vehicles the final reduction is achieved by chain drive which effectively reduces the torque on the drive lines and stub axle gears. Chain drives offer several advantages in the very heavy class slow speed vehicles and they may be used more extensively in the future despite their vulnerability to sand and grit abrasion.

Limited experience with the fluid coupling hydromatic type transmission has indicated that they have certain very desirable performances characteristics.

There is no doubt that fluid couplings with automatic transmissions or torque converters with semiautomatic or planetary type transmissions will be adopted in the near future. The extremely flexible application of power through these units with the elimination of fumbling with gears and abuse of clutches is too great to be ignored. It is not improbable that the use of such transmissions will permit substantial reductions in engine power without sacrifice of average cross-country speed or conversely will permit an increase in average speed for the same horsepower.

Power steering has been used on the 12-ton tractors and on one of the 30-ton special units. Front axle loads of 14,000 lb and tires up to 18.00 × 24 size are difficult to handle on hard roads, and particularly difficult in sand or mud.

Heat rejection is second only to mobility in importance in establishing dependable desert transportation service.

The typical highway type vehicle is designed for continuous full-load operation at a maximum of about 100 F ambient temperatures when the vehicle is new and the heat radiating system is clean. In hard road operation these vehicles have proved to be deficient in cooling capacity, when new and clean, if subjected to continuous operation at desert temperatures of 125 F ambient and actual radiator inlet air scooped up off the hot road at 135 F. This severe condition is frequently aggravated by tail winds and by rapid and serious deterioration of the cooling system due to rust, sludge, and scale.

The desert vehicle, whether highway type or off-road type, must be able to operate under these conditions. Improvements have gradually been adopted that, in the case of the off-road vehicles, result in about 200% of the heat rejection capacity of the ordinary highway type vehicle and about 150% for the desert highway type vehicle.

Engine Cooling Aids

A number of remedies have proved useful and economical during the years of operation. For example, oversize radiators are used—2 sq in. of frontal area per cubic inch of engine volume. The U.S.A. standard is less than half that amount. Frontal area is much more important than depth of core. More than four rows of tubes are inefficient because any additional rows of tubes are working in hot air.

Volume of water is important because of the relatively rapid evaporation loss due to the low relative humidity of the hot air and the continuous operation at 180 to 210 F water temperature. Close-fitting deep fan shrouds are necessary because they prevent partial recirculation of the hot engine compartment air through the corners of the radiator, and because they effectively influence the efficiency of the fan and radiator.

Table 1—Recommended Governed Speeds

Class-Vehicle	Horse-Power	Governed Speed, mph	Resulting Average Dune Sand Speed, mph
Light Cars	100	50	25
1-Ton Trucks	94	37	20
4-Ton Trucks	165	31	15
8-Ton Trucks	165	25	12
12-Ton Trucks	290	25	12
Ambulance	150	Unlimited	—
Bus	165	31	15

Fans of large diameter, multiple blade construction, high speed, and large power consumption are required. In desert operation, 10 to 12% of the engine horsepower can advantageously be devoted to this service. Such power consumption is greatly in excess of customary highway design. Type and shape of fans and fan blades influences the power consumption and deserves special study. Mechanical simplicity and ruggedness are however equally important and some loss of efficiency can be tolerated to preserve those desirable features.

Hoses must be large size and of the very best materials and construction obtainable. They operate at near boiling temperatures a much higher percentage of the time than do the hoses used in domestic operation. Softening, collapsing, or separation and collapse of the inner liner are serious defects of cheap hoses and must be avoided.

Small or cheap pumps subject to impeller corrosion or failure will not deliver the volume of water required. Pumps that develop corroded, scarred or pitted shafts, and pumps that have inferior type packing glands or stuffing boxes will leak and waste water. They will permit lubricant to pass by the shaft into the water stream and fill the system with soapy, greasy scum. The best pump available is recommended and even the best types need continual care and proper lubrication.

Pressure caps are commonly used in the United States to raise the boiling point of the water and thus to increase the rate of heat dissipation above 212 F temperature. Such devices have been avoided on the larger truck units primarily because inexperienced personnel frequently remove the cap under pressure and are occasionally badly burned. Generally in such cases the water in the system gushes out and is lost, and water is precious in the desert.

A tight-fitting waterproof cap is used on the larger units. It prevents rusty surge water from spilling out on the hood and over the windshield, and forces surge water up into the gravity type surge tank.

Few vehicles in the United States are equipped with surge tanks, and those few have the vacuum type tank. The vacuum type tank must be used with a pressure cap. In theory it takes the radiator overflow as the engine becomes hot and permits it to syphon back into the radiator when the engine

cools off. In actual practice the engine is frequently not allowed to cool off and thus cannot syphon back its water. Generally the cap is pulled while the engine is still hot and the water stays in the tank, which must then overflow when the next surge takes place.

A gravity type surge tank has been developed that must be used in conjunction with a watertight cap (but not a pressure cap). It forces the surge water to flow up into an elevated tank on the vehicle hood. In this case, when the engine cools off, the water runs back into the radiator header; if the cap is removed, the water will immediately run back into the header.

This surge tank has a ¼-in. vent pipe. If the engine is pressed too far, this pipe will first allow steam to blow to the air in front of the driver's eyes. If he continues beyond the steam plume stage, it will throw rusty, hot water out on the hood and over the windshield.

Even the most careless driver will normally heed such a warning. If experience proves that he does not, it is suggested that the overflow be piped to the throttle and be squirted on the offender's foot.

Thermal Cut-Off Helpful

An overheat warning and engine cut-off control is advisable on all the larger engines and, in fact, should be used on all engines. But unless such control is correctly installed, it can be the cause of a great deal of vehicle lost time and serious aggravation to the drivers. If the cut-off control element is installed in the radiator header or the engine cylinder head outlet, or worse yet in the block or cylinder head, it will cut off at the desired temperature—say normally at 210 F. But as soon as the engine stops, the header or outlet temperature will immediately go up to 212 F or higher and will take a long time to cool off. During that cooling off period the engine is inoperable. The irresistible tendency is for the driver to pour cold water into the stationary hot engine or to short circuit the controls and run without its protection.

There is another disadvantage of locating the thermal cut-off in the radiator header or the engine outlet. If the adjustment of the unit accidentally or gradually changes to above 212 F, it may not operate at all; or if it drops below 200 F, it will be continually shutting the engine off.

Locating the cut-off element in the gravity surge tank eliminates many of these difficulties. The element can be set for 205 F. This will effectively eliminate the chances of getting out of adjustment above 212 F and does little harm if it gets out of adjustment below 200 F. It will not actuate until a surge of really hot water or steam enters the tank, and it will cool off rapidly so the engine may be restarted and filled with new water while it is running. Water should, of course, never be added to a stationary hot engine, but can be added to an idling engine, even if slowly boiling, without damage.

The desired oil pressure cut-off should be incorporated with the thermal cut-off. It should be installed on every vehicle to care for loss of oil, drop in oil pressure, or loss of viscosity.

Cooling water has been a matter of concern for years. The best available fluid so far used is distilled water mixed with a chromate salt inhibitor or with soluble oil to temper its vigorous solvent action. The service station stock of such water should be doctored with some violent smelling or tasting, but harmless, compound to discourage its use for drinking, washing, and laundry use.

Zeolite-treated water also has been used and inhibits scale formation. Boiler compounds have been tried, but are not recommended. Despite the most careful planning, raw well water, alkali ditch water, and even sea water, are poured into the radiators together with sand, dirt, lint and shreds of cloth, date pulp, coffee grounds, lube oils, greases and water pump grease. These mixtures form scale and greasy coatings in the block, cylinder heads, and radiators. They also form sludges and sediments that, combined with rust, may gather in the corners of the block and in the radiator tubes in sufficient quantities to obstruct the water flow in a short time.

Only remedy is to make the approved distilled water with chromate salt inhibitor or with soluble oil available at all service and check stations, and to exercise constant vigilance in the inspection and supervision. Frequent drainage of the radiator water and flushing with clean water is necessary. Treatment with acid to remove the calcium deposits and alkali to remove the greases is advisable.

These precautions are absolutely necessary if operation is attempted with highway-type cooling systems. They have no reserve cooling capacity and neglect will quickly reduce them to completely inadequate capacity, even for hard road operation.

The ordinary water temperature indicator used on the many highway vehicles is an inexpensive and frequently inaccurate instrument. It will not stand abuse from shock or neglect and therefore may give a wrong indication, and frequently fails altogether. A good top quality instrument should be used for both water and oil temperature indication. On the larger vehicles, a good temperature indicator for the oil in the transmission, the auxiliary transmission, and the transfer case should be installed.

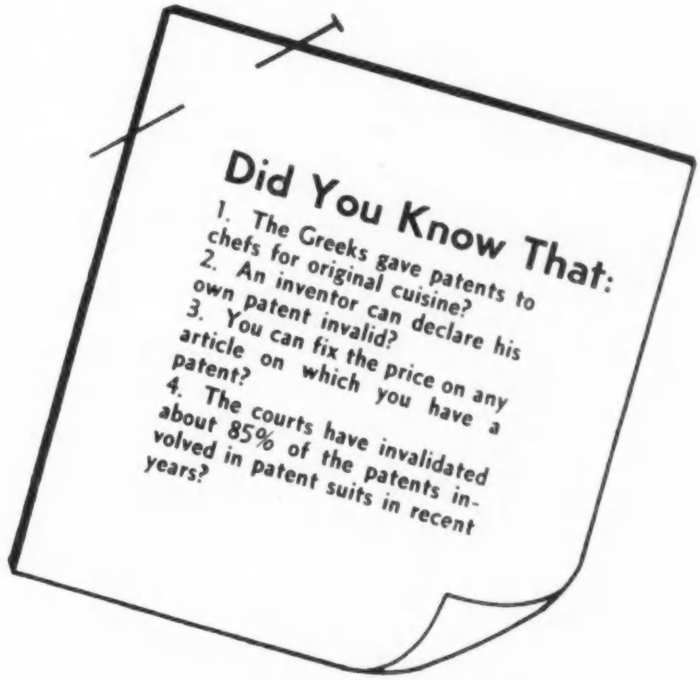
In the larger vehicles (150 hp and above), oil radiators should be provided because it is essential to maintain the minimum viscosity demanded by the engine. Water-cooled heat exchangers, using radiator water, are recommended. If properly designed and installed and if used with a thermostat-controlled water radiator, such heat exchangers will permit use of summer grade oil throughout the year.

Thermostats should by all means be used. The winter temperatures are low enough to cause either the off-road or desert highway type vehicles, with their oversized cooling systems, to operate at too low an engine temperature. This will vigorously promote bearing troubles and cylinder wear.

Antifreeze compounds in the radiators are not required in the coastal areas of Arabia, but might very advantageously be used in the interior and in the high plains areas. Freezing temperatures at night are frequently encountered during the three coldest months in those areas. If antifreeze is not used, care must be taken to cover the radiators and engine compartments at night and in some cases the fluid should be drained.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Facts About Patents



BASED ON PAPER* BY
W. R. Lane, Patent Counsel, North American Aviation, Inc.

* Paper "Why Patents," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950.

ABRAHAM Lincoln said: "The patent system has added the fuel of interest to the fire of genius." Time has proved the wisdom of these words, inscribed over the entrance of the U. S. Patent Office. But it also has clouded the concept of patents and brought conflicting attitudes on their status in our industrial life.

To clear the fog of misconceptions and biases surrounding patents, let us see what a patent is, how patents originated, the U. S. system, current thinking about them, and possibilities for improving the patent system.

What is a patent? It's a contract between the Government and the inventor. The inventor discloses the invention so completely so that anyone skilled in the art can make and use it. For his part of the bargain, he gets the exclusive right to the invention for 17 years. At the end of that time anyone may use the invention, without liability and without compensation.

Many authorities believe the patent system exists to reward inventors. But former Commissioner of Patents, Conway P. Coe, pointed out that the chief purpose of patents is not to reward the individual, but to advance the arts, the general welfare of the nation. The individual reward is only the lure to achieve this much broader objective.

Exclusive right of the patent gives the inventor complete control over manufacture, use, and sale of the invention. He also may prevent others from making, using, or selling it during the 17-year period of the patent grant.

The patent right often is held to be a monopoly. But in the case United States v. Dubilier Corp., the Supreme Court said: "Though often so characterized, a patent is not accurately speaking a monopoly . . . . The term monopoly connotes the giving of an exclusive privilege for buying, selling, working, or using a thing which the public freely enjoyed prior to the grant. Thus a monopoly takes something from the people. An inventor deprives the public of nothing which it enjoyed before his discovery, but gives something of value to the community by adding to the sum of human knowledge."

Birth of Patents

History is hazy as to origin of patent rights. In ancient Greece and Rome, inventions of such men as Archimedes were looked upon as mere frivolities. But according to a Greek compiler, inventors of new culinary dishes, in the City of Sybaris, several centuries B. C., were given exclusive rights to prepare them for one year.

Patents seem to have first appeared in Italy during the Middle Ages. There is evidence that patents were granted systematically in Venice, particularly to protect the glass-making art.

In early England, the Crown granted patents for

new inventions and discoveries. It also granted monopolies on ordinary commodities. These commodity grants accumulated so that monopolies soon covered many necessities . . . salt, iron, playing cards, paper, tin, vinegar, sulfur, and even transportation of beer.

Parliament fought the abuse and this led to the Statute of Monopolies in 1624. It prohibited granting of exclusive rights, except for new manufactures. Many heralded this as the beginning of patent law.

The U. S. Patent System

At the time the Constitution was framed, the colonists were chiefly farmers and producers of raw materials. These raw products were shipped to England to be manufactured into items of commerce. Men such as Franklin, Jefferson, and Washington, inventors in their own right, appreciated that invention had to be encouraged for the newly formed United States to survive. They also believed that new machinery and new products would enable them to compete with established manufactures throughout the world.

It was written into the Constitution (Article 1, Section 8) that Congress shall have power "to promote the progress of science and useful arts, by securing for a limited time to authors and inventors the exclusive right to their respective writings and discoveries."

The statute establishing the right to a patent (Section 4886) provides that "any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvement thereof . . . may, upon payment of the fees required by law, and other due proceedings had, obtain a patent therefor."

You get a patent by filing an application in the U. S. Patent Office, paying the fees, and convincing the patent examiner that the subject matter is not only patentable, but properly claimed.

The patent application consists of a specification or written description, a drawing—where the nature of the invention permits, and a claim or claims which distinguish the applicant's invention from the prior art. The claims cover only that which constitutes applicant's contribution to the art; and by their terms, exclude that which does not belong to the applicant.

The U. S. Patent Office examines the application. It maintains a corps of examiners, each skilled in his particular field. These men determine the scope of the temporary monopoly to be granted to the inventor. Although a Government agency grants the patent, and it carries a presumption of validity, there is no guarantee of the rights granted. The inventor merely has a document supposedly enforceable by court action.

Privileges of Patents

Once the inventor has a patent he can use it in several ways. He can feel free to invest money in the new product covered without fear of competition during the life of the patent. He can induce others to risk capital on the basis of the temporary advantage granted by the patent. He can divest himself of his interest in the patent by assignment, or he may license others under it on an exclusive or nonexclusive basis.

A patent owner can set the price at which patented products can be sold. The courts are still upholding price-fixing agreements of this type.

The owner cannot use the patent to control the sale of unpatented products. Patents may not be misused to establish monopolies in unpatented materials. Sale of patented items can be restricted from a territorial standpoint. But this control does not extend to their resale.

An inventor now can deny the validity of a patent granted to him, under the Scott Paper Co. v. Marcallus decision. In that case, the inventor divested himself of rights in the patent by an exclusive license. He then violated the license by manufacturing and selling in competition with the exclusive licensee. The inventor showed the patent was not valid because the invention already had been described in an expired patent.

The licensee cannot insist that the inventor or patent owner stay out of certain fields not covered by the patent. The courts forbid such restriction because it stifles inventive genius.

The courts do permit cross-licensing of patents. But price fixing in cross-licensing agreements among patent owners or patent pool members is illegal. Cross-licensing or patent pools formed merely to avoid litigation or for mutual protection are permissible. All members of the trade may have licenses provided the terms are nonrestrictive and nondiscriminatory.

Example of an effective cross-licensing agreement in the aircraft industry is the Manufacturers Aircraft Association Cross-License agreement. Practically all the major airframe manufacturers are members of this Association.

The patent owner cannot prevent use of the invention by or for the Government. But he can sue the Government for reasonable compensation.

Attitude Toward Patents

Function and operation of the patent system have been bones of contention since its inception. Thomas Ewing, former Commissioner of Patents, summarized these controversies in the following:

"The patent system is the subject of criticism by every class of people who give it any attention. Many object because of the monopolistic character of the grants; many that it throws people out of employment. Some manufacturers claim it operates to the disorganization of their business; inventors that they cannot find a market for the product of their labors. Investors tell of grievous losses. The public complains of high prices and suppression of useful inventions. And the expense and burden of litigation is all but intolerable.

"I believe that these criticisms can be met with fair success, except the one about the cost of litigation."

Here is how Senator O'Mahoney, chairman of the Temporary National Economics Committee, in 1939, summarized information obtained at the Committee's patent hearings:

"There seems to be a general agreement by these witnesses, as well as those who previously testified at the Department of Justice hearings some weeks ago, that inventors and business still need the pro-

ection and stimulation of patents. There was practically unanimous agreement among the witnesses that Congress, by enactment of the patent law, has given this country a system far superior to that which exists in any other country."

Prof. Walter Hamilton, author of Temporary National Economic Committee Monograph 31, contends our patent system is obsolete because conditions of invention have changed. Groups of technicians working in corporation laboratories have superseded the garret inventor. He believes that assignment and license has put the inventor's exclusive right into the hands of big business.

Today the Patent Office is swamped with applications. There were 130,392 applications as of Aug. 8, 1950, awaiting Patent Office action. A great many more are on file.

Nearly 100 patents are being granted every day. Of these, 51% are being granted to domestic corporations; 4% to foreign corporations; and 45% to individuals.

For about 15 years, and until the past few months, the courts have been invalidating about 85% of the patents coming before them. Quite recently, in a dissenting opinion, Mr. Justice Jackson, of the U. S. Supreme Court, said: "The only patent that is valid is one which this court has not been able to get its hands on."

Apparently the courts felt they must protect the public against the temporary monopolies given by the Patent Office. Yet the courts constantly uphold copyrights on songs, verses, cartoons, and the like. In fact, the patent and copyright laws find their source in the same paragraph of the Constitution.

Owners are now quite reluctant to sue on their patent rights for fear of having their patents invalidated. Powerful manufacturers, many argue, can feel free to infringe patent rights of those who do not have the money or inclination to go to court and defend their rights, especially when chance of success is small.

Decisions handed down by the U. S. Supreme Court during its October, 1949 term should be encouraging to patent owners. In several cases patents were held to be valid and infringed.

Suggested Improvements

At present the patent system needs clarification, if not revitalization. Issued patents should carry a strong presumption of validity. Now it is an instrument which apparently anyone willing to spend the money and time can invalidate.

This calls for better examination in the Patent Office and a clear, consistent treatment of patents by the courts. Legislative action may possibly clarify the situation by clearly defining an invention, and how patents may be handled without violating antitrust laws or antimonopoly practices.

We must avoid the possibility of people refusing to disclose their inventions. If the trend of the last 20 years continues, eventually attorneys will advise their clients not to disclose their inventions. Certainly this would deter promotion of useful arts and sciences, contrary to the Constitutional provisions forming the basis of our patent laws.

Patents are essentially a part of our free enterprise system. Let us hope that the Congress, the courts, and the U. S. Patent Office will preserve a patent system that helped build the world's greatest industrial organization.

(This paper is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Council to Name 1951 SAE President . . .

In view of the untimely passing of James E. Hale, SAE President-elect for 1951, it becomes the responsibility of the 1951 SAE Council to "select one of its number to fill the vacancy until the next annual election."

The 1951 Council will first meet during Annual Meeting week, when it becomes a legal entity following report by the Tellers of Election at the Business Session of the Society on Tuesday, January 9.

Its action in electing the 1951 President is guided by C25 of the SAE Constitution and By-Law 18:

"C25. Should a vacancy occur in the Council or in any elective office except the Presidency, through death, resignation or other cause, the Council may select a voting member of the Society to fill the unexpired term of the office which has become vacant. Should a vacancy occur in the Presidency, the Council shall select one of its number to fill the vacancy until the next annual election."

"B18. If a nominee listed on the official ballot and elected by the membership is unable to serve because of death, withdrawal of his name, resignation or other cause, the Council, at its first meeting in the next administrative year, shall fill the vacancy thus created, as provided in Section C25."

The February issue of SAE Journal will bring to members the results of the Council's action—the name of the 1951 President and that of the member elected to fill the 1951 Council office vacated by his election.

EXCERPTS FROM PAPER* BY

Maj.-Gen. F. O. Carroll, Commanding General, Air Engineering Development Division

* Paper, "The Arnold Engineering Development Center," was presented at the SAE National Aeronautic Meeting, Los Angeles, Sept. 30, 1950.

New Development Center

IT is my purpose to describe the technical mission of the Arnold Engineering Development Center—why we need it—what it will accomplish for the common good. In particular, I wish to point out that the AEDC is not the "private and personal" property of the Air Force—or of the Army or Navy, but rather that it is an evaluation and development tool intended for the use of *all* parties and agencies—in government, in industry, and in science—interested in the primary objective of assuring this Nation's position at the very forefront of the aeronautical art. The project, from its very inception, has been developed and discussed in these unitary terms. It was so presented to the Congress. It is the intention of the Air Force to carry out this unitary concept in its dealings with the other services, with industry, and with scientific and research institutions, in the use of the AEDC facilities.

That we are indeed faced with critical decisions is being demonstrated to use day by day—even hour by hour. The test facilities planned for AEDC are sorely needed. The Air Force therefore, with the assistance and counsel of the Army and Navy, the NACA, industry, and science, is bending every effort to bring these facilities into being at the earliest possible date. Contracts are being let and construction is actually underway at the site at Tullahoma, Tenn.

Original Concept By Air Force

One of the first indications of postwar facility needs in the Air Force occurred back in August of 1944 at Wright Field. This date is important in that it shows the length of time that has elapsed since we, at Wright Field, first thought in terms of urgently needed expansions in our research and development facilities—further, it points up the fact that in 1950 we *still* do not have the test facilities required to meet the research and development needs of the country.

General Arnold also recognized these deficiencies at that time and took action to remedy them. In November of 1944, he asked Dr. Theodore von Karman (who presently heads the Air Force Scientific Advisory Board and is also chief scientific advisor to AEDD), "to investigate all the possibilities and desirabilities for postwar and future war's development as respects the Army Air Force."

From the studies of the von Karman group came vital recommendations for future Air Force research and development facilities, including the recommendation that a new Air Engineering Development Center be built to handle the many problems which the era of jet propulsion and supersonic flight were thrusting upon us.

Coordination With Other Agencies

AEDC in its present form is the end result of careful planning and coordination by all the agencies and groups concerned with these facilities. The amount of detailed study and the thoroughness of review required in a project of this complexity and magnitude necessarily covers a considerable period of time.

AEDC—as it now is being built—consists of three main test facilities, together with the necessary central supporting facilities.

High-Altitude Engine Test Facility

The High-Altitude Engine Test Facility is the first facility planned for the Center. The engine test unit will make possible the testing of turbojet and ramjet powerplants under simulated flight conditions of speed and extremely high altitudes, both under direct-connect and free jet tests. The nucleus of the unit is a jet engine test plant acquired from the Germans at the end of World War II and modernized and expanded to increase its capacity. This German equipment has been in storage since the end of the war, since our existing facilities lack the power capacity to operate it.

The Engine Test Facility will test jet engines much larger than those now used in our aircraft and will have a testing capacity six to eight times that of Wright Field. It will require about 75,000 hp to operate and an over-all space requirement of approximately 450 × 600 ft. The air supply and test chamber components, as well as the exhaust components, will be under cover. The area between is open to accommodate railroad tracts and movement of test and exhauster components.

The Engine Test Facility is composed of five basic

Facilitates Aircraft Research

Gales running into thousands of miles per hour will be developed in wind tunnel to be installed in gas dynamics building, slated for completion in 1952

components: refrigeration drying equipment, four air supply compressors, three test chambers and a test bed, exhaust gas coolers, and six exhausters.

Air at moderate pressures for simulated supersonic ram may be supplied to the test chamber header by the four parallel air supply systems. Two parallel exhauster systems using six centrifugal compressors will reduce the pressures at the test cell exit to accomplish simulated pressure altitudes.

One engine test bed and three test chambers are provided for installation and development testing of propulsion units. The test chambers are about 12 ft in diameter and may be extended to various lengths by the addition of suitable sections. The engines will be prepared for test and mounted. When ready for test the engine is then brought to the test chamber via railroad tracks, which lead to all chambers. Quick disconnect doorways provide convenient access. Each chamber has a connecting control room, complete with requisite controls and instrumentation necessary to accomplish all testing currently contemplated.

Atmospheric air is compressed by the four centrifugal compressors, then dried by cooling in a 3-stage finned-type cooler so that less than 1½ grains of water per lb of dry air exists in the air directed into the test chambers. For high-altitude temperature simulation the air is cooled by expansion through a cooling turbine with an accompanying pressure reduction. Temperatures as low as 120 F may be achieved. Supersonic ram conditions requiring higher temperatures for simulation of standard conditions are met by circulating the dry air through heat exhangers, which utilize the heat of compression for heating the dry air. An inlet temperature range from 120 F to 300 F may be provided by valve regulation of the relative amounts of air passing through and around the turbine, and that recirculated through the heat exhanger. Higher supersonic ram conditions requiring elevated inlet temperatures are met by routing the air through oil- or gas-fired tubular-type heaters, where temperatures up to 650 F are obtained prior to delivery through a second header to any test chamber.

Test engine exhaust gases after passing through a diffuser are discharged either directly to the atmosphere through stacks or through the two parallel exhaust compressor systems. When simulating altitude conditions, the gases discharged through the exhauster system are cooled by water sprays to 660 F or to saturation before passing to exhaust gas coolers, which further cool these gases. The gases then enter a second header leading to exhauster compressors, which raise the gas pressure to 15 psia so that it may be discharged back to the atmosphere. Control of altitude pressure in the test cells is provided by valves located downstream of the exhaust gas coolers. With proper intercooling and valving the exhausting of the two parallel circuits may be operated in either series or parallel combinations.

For operation with an atmospheric exhaust at the cell outlets, exhausters may be connected into the air supply circuit to provide maximum available

pressures; for medium mass flows or for pressures up to approximately 35 psi at mass flows beyond 300 lb per sec. Atmospheric intake to the test chamber will also give exhauster mass flows beyond 300 lb per sec. It may be noted that one test chamber may be operated at full air supply capacity, exhausting to atmosphere, while another test chamber may be operating simultaneously with an atmospheric inlet and at the corresponding exhauster mass flow. Combined air supply and exhauster operation also provides a very high volume of air per second.

Gas Dynamics Facility

The second principal test unit is the Gas Dynamics Facility—capable of developmental testing of models of aircraft and guided missiles, and their components, through the supersonic and into hypersonic speed ranges, at very high Reynolds numbers. Buildings house the compressor plant and the testing area, leaving much of the ducting exposed. The overall area required for this facility is 400 × 500 ft.

The Gas Dynamics Facility is a supersonic and hypersonic wind tunnel group designed for the aerodynamic development of supersonic aircraft and missiles. The Mach number range of this facility is extremely wide; it extends from 1.2 to above 5, so that it is possible to test the models of supersonic aircraft and guided missiles now being developed. The major feature of the facility is that this large Mach number range has been combined with a wide Reynolds number range, having a maximum Reynolds number considerably greater than has been available up to the present for aerodynamic development in supersonic wind tunnels. This has been done partly by using fairly large test sections—40 in. square—but mainly by the more economical and convenient method of increasing the pressure of the supply air to more than 100 atmospheres at high Mach number. In this way, Reynolds numbers approaching those of typical missiles in flight are provided by the facility over most of the Mach number range.

The facility consists of an extremely flexible compressor system driven by electric motors totaling 90,000 hp; two 40 × 40-in. test sections, each equipped with adjustable nozzles, tunnel ducting, optical instruments, force and pressure measuring instrumentation, heat exchangers and driers, and buildings to house the compressor plant and test sections, with provision in the latter for office space. Though the major facility consists of two major test sections, the extreme flexibility of the centrifugal compressor system makes it possible to operate other test sections from the same compressor plant. There are 12 centrifugal compressors in 8 series stages, all being driven by synchronous electrical motors. The higher stages are unique in centrifugal compressor design; the air from the last stage of compression has a density approximately one-fourth that of water. Also of interest is the small size of the nozzle throat at high Mach number—specifically, a small fraction of an inch at the highest Mach number with a 40-in. test section. Such examples are indicative of the types of problems which become evident in the designing of such a facility.

High temperatures at high Mach numbers will be encountered. At high Mach numbers the nozzle expands the air to such an extent that the pressure falls to about 1/250th of an atmosphere absolute, and if the air were at room temperature before expansion, its temperature would fall to only a few degrees above absolute zero. This is well below the liquefaction point of both oxygen and nitrogen; and it is therefore necessary to heat the air to avoid the formation of liquid air in the test section.

The maximum Reynolds numbers attainable in the Gas Dynamics Facility are fairly constant throughout the Mach number range and are comparable with full-scale supersonic aircraft and missiles. This feature makes this tunnel of the greatest usefulness from the standpoint of aerodynamic development of very high-speed aircraft.

Propulsion Wind Tunnel

The third principal test unit scheduled for construction at the AEDC is the Propulsion Wind Tunnel—designed for development testing of full-scale, operating, ramjet and turbojet powerplants, as installed in missiles and aircraft, as well as full-scale components of aircraft and missiles. The speed range of this tunnel extends from the high transonic realm well into the supersonic. Approximately 200,000 hp will be required to operate the tunnel, a power demand equivalent to the entire greater Nashville area. The overall area required for this facility is approximately 300 × 450 ft.

The Propulsion Wind Tunnel will be a continuous-flow closed-circuit tunnel with two test sections, one for the transonic range and one for the supersonic range. The transonic test leg will be installed initially; the supersonic leg will be installed as additional funds are made available. The circuit arrangement is such that installation and instrumentation work can proceed in one section while the other is engaged in test operation.

The transonic test section will be octagonal, approximately 18 ft across the flats. The Mach number range will be from 0.8 to approximately 1.4. The supersonic test section will be 16 ft square and will cover the Mach number range from 1.4 to more than 3.0.

The facility will include tunnel ducting, nozzles, a precooler and aftercooler, combination systems for scavenging of combustion products from burning powerplants, systems for providing make-up air, a compressor system, valve systems for isolating either of the test sections from the circuit, optical instrumentation systems, force measuring systems, and buildings to provide office space and cover for each test section, and cover for the electrical drive components.

The operating characteristics of the Propulsion Wind Tunnel are outstanding. It is obvious that full-scale Reynolds numbers will be obtained throughout the speed range of the tunnel because full-scale turbojet and ramjet installations will be tested. It will be possible to simulate altitudes in the tunnel which correspond to the actual operating conditions of the aircraft or missile powerplant under test. It will also be possible to simulate exactly, under most of the Mach number ranges, actual temperature conditions as well as altitude conditions.

It is apparent that this facility quite adequately

meets the requirements for development testing of full-scale powerplant installations. The capability of the tunnel to provide matched temperature and altitude conditions through a wide range of Mach numbers and altitudes, while still permitting use of full-scale operating plant installations, greatly enhances the practicability and utility of such a facility. Though designed primarily as a propulsion tunnel, it fills an urgent second need as a development facility which can provide development testing of full-scale or very large-scale models of aircraft and missiles or components without operating powerplants, still maintaining full-scale Reynolds numbers and matched temperature and altitude through the same range of Mach number and altitude. These features combined make this a unique and extremely valuable facility for use in furthering development of aircraft and missiles.

Central Facilities

The test facilities are, of course, the reason for building the AEDC. But such facilities must be supplied with utilities and supporting services to help them in operation. All these contributing factors to the successful operation of the Center have been assembled into one general unit known as Central Facilities. To get some idea of the complexity of the auxiliary requirements for such an installation, let us consider some of the ramifications of the Central Facilities.

A railroad extension of seven miles will be built to convey materials to the site, and the internal system of railroad spurs will add several more miles. The local roadnet in the vicinity is being replanned to provide rapid access by all forms of highway vehicles.

The communication system has grown to complex dimensions, due to the many different functions it will be called upon to perform. For example, in addition to the normal telephone circuits, it must transmit fire alarms and police calls, provide for the dispatching and control of electric power, and make it possible to accomplish several unusual forms of intercommunication, including data transmission from the test facilities to the computing section.

The three major test facilities also present new problems in the supply of electricity, water, steam, fuels, and so on, at the rates necessary to satisfy maximum demands at full-load conditions and also in the rapid cutback to minimum requirements necessary for standby between test runs.

As an example, the steam generating plant will supply 170,000 lb steam per hr but must be able to cut back to as little as 5,000 lb per hr in a minimum of time. The boiler plant must be flexible enough to satisfy these extremes for extended periods and also must be able to adjust rapidly to any load in between these limits.

The primary water pumping plant will be capable of operating from 100,000 gpm down to a no-flow condition in a short space of time. The upper reservoir will have water drawn from it and any rate from the maximum test requirements of 150,000 gpm down to the normal requirements for sanitary services on a holiday.

There is another most important phase of the project—a phase dealing with the ways and means by which the Air Force, industry, and science can work together in the development and use of the AEDC test facilities.

Industry and Educational Advisory Board

I stated at the beginning of this presentation that the Arnold Engineering Development Center is intended for the use of all agencies for the common good and that the Air Force will bend every effort to operate the Center on a unitary basis. To assist us in accomplishing this objective, we have set up an Industry and Educational Advisory Board. The details of organization of this Board, as well as the objectives and method of operation, are being carefully worked out with the help and close cooperation of Admiral Ramsey and the Aircraft Industries Association, and the Air Force Scientific Advisory Board, whose chairman is Dr. Theodore von Karman.

The member of the Board has been taken from the aircraft industry and from the academic world. The members of the Board are: Gen. E. M. Powers, vice-president, Curtiss-Wright Corp.; Wright A. Parkins, engineering manager, Pratt & Whitney Aircraft; Dr. William Bollay, technical director of Aerophysics Lab, North American Aviation, Inc.; John Buckwalter, assistant to vice-president, Douglas Aircraft Co., Inc.; A. T. Colwell, vice-president, Thompson Products, Inc.; Prof. John Markham, professor of aeronautical engineering, M.I.T.; and Dr. E. C. Brehm, president, University of Tennessee.

In general, the Board will report to the Chief of Staff of the Air Force on the technical adequacy of the several AEDC facilities as well as advising on the several operational phases of the program to be conducted at the AEDC. Further, the Board will consult with and advise the Commanding General, AEDC, on the many problems connected with the project and on suitable methods of solving them.

Aro, Inc.

The decison was made by the Air Force that the management and operation of the AEDC, when the construction is completed, will be undertaken by a private corporation under contract to the Air Force.

This new corporation, incorporated in the State of Tennessee, and known as ARO, Inc. is an organization whose sole interest, activities, and responsibilities will be the effective and economical management and operation of the Arnold Engineering Development Center.

It is intended that the corporation will assume complete charge of the management and operation of the test facilities at Tullahoma. I wish to emphasize that the ways and means of conducting the test work at the Center—as well as the allocation of testing time—will be worked out to the satisfaction of all concerned.

In general, it can be said that ARO's organization and relationship to the Air Force is similar to the Atomic Energy Commission's contractural relationship with private corporations for the operation of its facilities, and to the U. S. Navy's contractural relationship to certain corporations in the operation of certain Navy test facilities.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price 25¢ to members, 50¢ to nonmembers.)

Five Steps in Setting Up a

WE credit good planning and operating policies for success of facilities for heat-treating and machining crawler tractor and grader gears at Allis-Chalmers' Springfield Works. Installation of the department grew out of this five-part program:

1. Determination of general heat-treating and related machining practices.
2. Selection of type and quantity of required equipment.
3. Engineering an efficient department layout with emphasis on safety and working conditions.
4. Provision for necessary metallurgical control.
5. Planning a program for regular and preventive maintenance.

Although the Springfield Works never made any gears, it had tested gears for many years both on dynamometers and in the field. Test results clearly showed gear properties required for longest service life; but they pointed up no measurable preference for ways of getting these properties, even though they covered gears of many different steels, heat-treated by numerous methods.

All gave quite similar life when the end metallurgical and residual stress conditions satisfied established limits. This made it much easier to determine general practices. All that remained was to find an efficient method of getting these end conditions.

With factory cost, product quality, and working conditions foremost in our minds, we arrived at the following practices:

1. All gear forgings are made of regular quality open hearth steels, using SAE 8600 H series wherever possible. For light, fine pitch gears, we use SAE 8620 H, while for coarse pitch, heavy final drive gears we use SAE 8627 H. We prefer this steel series for its low cost and adaptability to our heat-treating processes, as well as its desirable combination of physical properties.
2. Machining practice on spur gears is to rough and finish hob (or shave) from a finish broached bore.
3. Steps on the sides of gears to be die quenched are held to a 0.001-in. tolerance for quench die fit, which in some cases entails grinding.
4. The gas carburize and direct quench procedure is used nearly exclusively. No machining is done between the carburize and harden operation, even though this requires a copper plating operation on some parts.
5. Small gears are quenched on splined plugs, locating on the major or root diameter of the bores, which are held to a 0.001-in. tolerance in broaching.
6. All gears are divided into two furnace groups. The first, consisting of more or less flat gears, are scheduled through continuous gas carburizers. The second group, run in pit-type carburizers, consists of long gear shafts and stem pinions which are suspended vertically to reduce distortion. These small pit-type carburizers also provide for desirable flexibility of equipment in the department.
7. All quench tanks are equipped with variable-speed propeller agitators to insure that no steel is slack quenched. Some tanks can develop a Grossman H value of 0.6.
8. Quenching oil is of the straight mineral type of a 100 SUS at 100 F viscosity. It is maintained at a temperature of 110 to 120 F and is constantly recirculated through screen type filters to remove foreign matter.

Some of these practices might seem to indicate

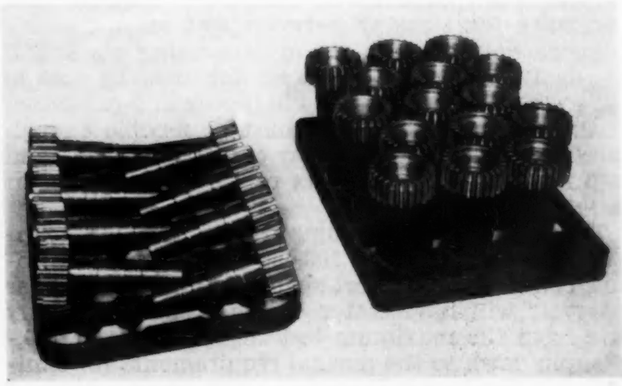


Fig. 1—The carburizer tray loading at left is inefficient as compared with the one at right. It holds only about half the number of input shafts and is less conducive to uniform quenching of gear teeth than the one at right

Heat-Treating Department

EXCERPTS FROM PAPER* BY

Roy F. Kern, Metallurgist, Allis-Chalmers Mfg. Co.

* Paper "The Heat-Treatment of Crawler Tractor Gears," was presented at SAE Central Illinois Section, Peoria, Feb. 22, 1950.

a disregard for factory cost (particularly in machining). But we have found it more efficient to machine a gear to such tolerances as are necessary for trouble-free heat-treating, than to become penny-wise in the machining and constantly in trouble with excessive heat-treating costs and poor quality. We have learned that a minute delay in our heat-treating department costs more than twice as much as a similar delay in our machine shops.

Equipment selection runs a close second to development of general machining and heat-treating practices. Our equipment was selected with these six factors in mind:

1. It must be capable of producing parts of the prescribed quality.
2. It must be dependable and easy to maintain.
3. It must be soundly designed and made of the highest quality materials.
4. It must be safe for an employee to operate with minimum effort.
5. It must operate without creating undesirable working conditions.
6. It must do all these things at lowest possible operating costs.

In determining the quantity of heat-treating equipment required for expansion of facilities, we first thoroughly study all gear drawings to:

a. Schedule each part into either continuous or pit-type carburizing furnaces.
b. Determine the most efficient loading in accordance with normal furnace design and uniform heating and quenching.
c. Calculate carburizing cycles for the specified case depths.

Loading determination cannot be overstressed because this, we feel, largely establishes our factory cost of heat-treating. We consider no plant floor space so valuable as the inside of a heat-treating furnace. To achieve low factory costs, we try to keep it occupied. A furnace operated at only half its rated capacity is no less ridiculous than using a 10-ton truck to haul 5-ton cargos.

In this work the furnace alloy manufacturers are of considerable help. By proper fixturing, we not only get lower factory costs, but actually provide for higher quality due to uniformity of heating and quenching. On the left in Fig. 1 is shown a possible method for loading an input shaft for heat-treatment in a tray type furnace (eight pieces per tray); on the right is shown what we consider efficient tray loading (15 pieces per tray).

The heat-treating cost of the input shafts shown on the left in Fig. 1 would be nearly twice that of those heat-treated as shown on the right; and nearly twice as much furnace equipment would be required to produce a given quantity. The gears on the left would not quench as uniformly as those on the right, since the teeth rest on a hot tray.

To the design engineer this loading efficiency means not only an assurance of uniformly high quality, but protection against design criticism that it cannot be made at a satisfactory cost. Often cost reduction measures are directed at a design when heat-treating or other shop inefficiency is actually at fault.

Our policy on fixtures is essentially as follows:

1. Let the suppliers design the fixtures in accordance with good foundry or fabricating practice.
2. Purchase fixtures on performance (cost per hour life at heat or per quench) and not merely on cost per pound.
3. Keep the fixtures' sections light for efficient heating, quenching, and initial cost. Designs are often very inefficient in the work-to-alloy weight ratio which we prefer to maintain at a minimum of about three to one.
4. Maintain heat-treating alloy-life records.

Furnaces frequently are overloaded, not necessarily as a production efficiency measure, but due to either improper load calculations at original installation or production schedule increases. Remember that heat-treating equipment operates at destructive temperatures. Load studies should indicate a delay factor for late material deliveries and both regular and preventive maintenance. We use a delay and maintenance factor of 15% in our load studies.

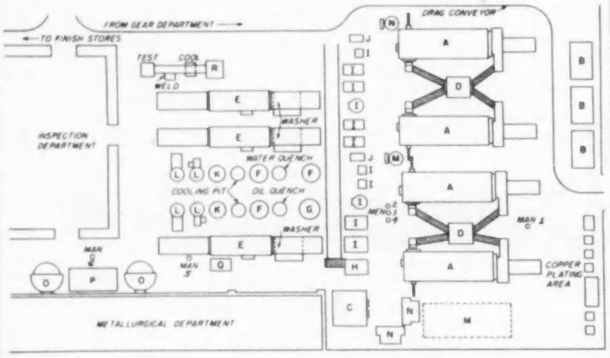


Fig. 2—Layout of the gear heat-treating department at Allis-Chalmers' Springfield Works. Equipment shown is as follows: A, Surface Combustion Radiant tube-fired tray pusher carburizing furnaces; B, Surface Combustion RX atmosphere generators; C, Surface Combustion rotary-hearth tube-fired hardening furnace; D, Surface Combustion Standard-Rated large oven furnaces; E, Surface Combustion Flight-Type conveyor air draw furnaces; F, Hevi-Duty carburizer; G, Leeds and Northrup carburizer; H, Hannifin centrifugal quenching press; I, Gleason quenching press; J, Dennison hydraulic arbor press; K, Leeds and Northrup Homo-Draw pit furnace; L, Lindberg Cyclone pit draw furnace; M, Bell and Gossett quench oil conditioning system; N, propeller-agitated quenching tank; O, W. W. Style table type blast cleaning machine; P, American Wheelabrator "Wheelapeening" machine; and Q, Hannifin 150-ton hydraulic straightening press

Third phase of the program, laying out the heat-treating department, should reflect these five principles:

1. Use floor space efficiently.
2. Establish a direct flow of material through the department.
3. Use manpower efficiently.
4. Maintain the best possible working conditions for manpower required.
5. Provide for future expansion of the department.

Layout is obviously important. Not only is floor space extremely valuable, but correct positioning of equipment yields higher quality by minimizing missed operations and by reducing damage in handling. Proper layout with consequent smooth department operation also has a desirable effect on the morale of employees, since efficiency instills job pride.

Direct flow of material is usually quite simple to provide, but the efficient use of manpower is more difficult due pricipally to the long cycles necessary on some heat-treating operations. Our general rule in this respect is to double up on duties until a man is occupied at all times. This is accomplished as shown in Fig. 2.

Note that man No. 1 charges all continuous carburizing furnaces. Men Nos. 2, 3, and 4 quench all gears, deliver them to the low temperature draw furnaces, and thence to the shotblast machines, where man No. 6 does all blast cleaning by operating three machines. Parts such as stem pinions requiring straightening are scheduled through the No. 1 Draw Furnace and this operation performed hot by man No. 5. With these six men we produce approximately 1800 lb per hr of carburized and hardened gears.

We recognize the extreme importance of reducing operator fatigue and every effort is made in that direction to maintain a suitable level of productivity. Power hoists, roller conveyors, and other handling equipment keep the physical effort required from being excessive. Installation of numerous ventilating and exhaust systems also improves working conditions.

Future expansion is provided for since five additional continuous carburizers may be installed parallel to the No. 4 carburizing furnace. Such is the case also for the quenching presses and the gear draw furnaces. Other equipment may be supplemented in one direction or another without creating a congested condition. Photos of the layout at Allis-Chalmers are shown in Fig. 3.

Control Key to Quality

Even with proper layout, machining, and heat-treating practices, we feel that certain factors within a heat-treating department must be closely controlled to insure a uniformly high quality product at a suitable factory cost. These factors are: (1) heat-treat operations, (2) dimensional quality, (3) carburizing quality, (4) quenching practice, and (5) fuel utilization.

Control of heat-treating operations includes the specification of furnace temperatures, loading schedules, furnace cycles, carburizing, and quenching tooling to be used, and the standard times for each operation. To accomplish this, heat-treat operation sheets are prepared on each part. This sheet specifies just how a part is to be heat-treated. It is important for quality control, the maintenance of production standards, and furnace load records.

Control of dimensional quality is assured by the immediate and constant "spot" inspection of the gears at the quenching presses as they are hardened. Gears from new heats are run through the department in pilot quantities so that machining adjustments may be made, if necessary, when the production lot in that heat of steel is scheduled to be machined.

Case depth and carbon concentration control is maintained by microscopic and step tests as well as daily gas analysis on each furnace and on the atmosphere generators.

From a metallurgical standpoint the most fascinating control work is that on quenching of the gears. Here we feel is an often sadly neglected phase of gear heat-treating. Cooling rate studies are made on each gear.

Points are selected at significant locations on the gear. After sectioning a gear that had received the specified heat-treatment the hardnesses were checked at these locations. With the end quench hardenability available for the applied heat of steel, it was possible to determine the approximate cooling rate in the quench at each of these points. This determination of cooling rates, which is rechecked for nearly every new heat of steel, is useful for several reasons.

1. It indicates the severity and uniformity of our quenching.
2. It indicates the correctness of our steel selection for the sections involved and the type of quench used.
3. It permits us intelligently to assign heats of

steel to certain part numbers for an improvement in quality or uniformity.

4. It enabled us initially to determine scientifically the points on the hardenability bands of the H-steels which we purchase, and to constantly recheck our choice of these points.

Selection of points on the H-steel hardenability bands was made by preparing a frequency curve plotting the cooling rates at the pitch line in the core of our gears against the number of gears for that particular cooling rate.

The hardenability band points which we specify for our H-steels are those at which the crest of the foregoing frequency curve exists. To provide for still greater uniformity, the cooling rate in our quenching was reduced on those gears showing excessive core hardnesses and increased on those showing low core hardnesses. The steels in a few gears were sometimes found to be far enough off in hardenability level to warrant a steel change to obtain maximum metallurgical quality.

The controlled severity possible with modern quenching equipment provides for very close reproducibility of these cooling rates. This results in greater uniformity from gear to gear and from one heat of steel to the next. This control of quenching also enables us to use lower priced steel, such as SAE 8620 H, over a wider range of sizes and designs than is possible with unknown and/or uncontrollable quenching.

As in the control of quenching practice, we found an often neglected phase of efficient heat-treating department operation is the use of fuel or combustion control. Constant checking of flue gas analyses help us maintain a high combustion efficiency, which keeps our fuel costs to a minimum.

Maintenance Prevents High Losses

In normal operation of equipment in our gear heat-treating department, each furnace usually contains several thousand dollars worth of semi-finished gears. Failure of these furnaces to operate properly when charged with this investment in material would be disastrous. This possibility of failure in operation does not necessarily indicate faulty design, but is ever-present, simply because this equipment is operated at destructive temperatures. We found it most advantageous to set up a maintenance program consisting of:

1. Scheduled shut-downs for internal inspection and replacement of parts before complete failure.
2. Regular carbon deposit burn-out operations to preserve heat-resistant alloy furnace parts and provide for closer atmosphere control.
3. The stocking of a set of spare parts as recommended by the manufacturer. This is important since these furnaces are of special design and some spare parts cannot be obtained on short notice in the event of a breakdown.

To date with this maintenance program, we have neither lost nor had to salvage a single gear due to failure of furnace equipment.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

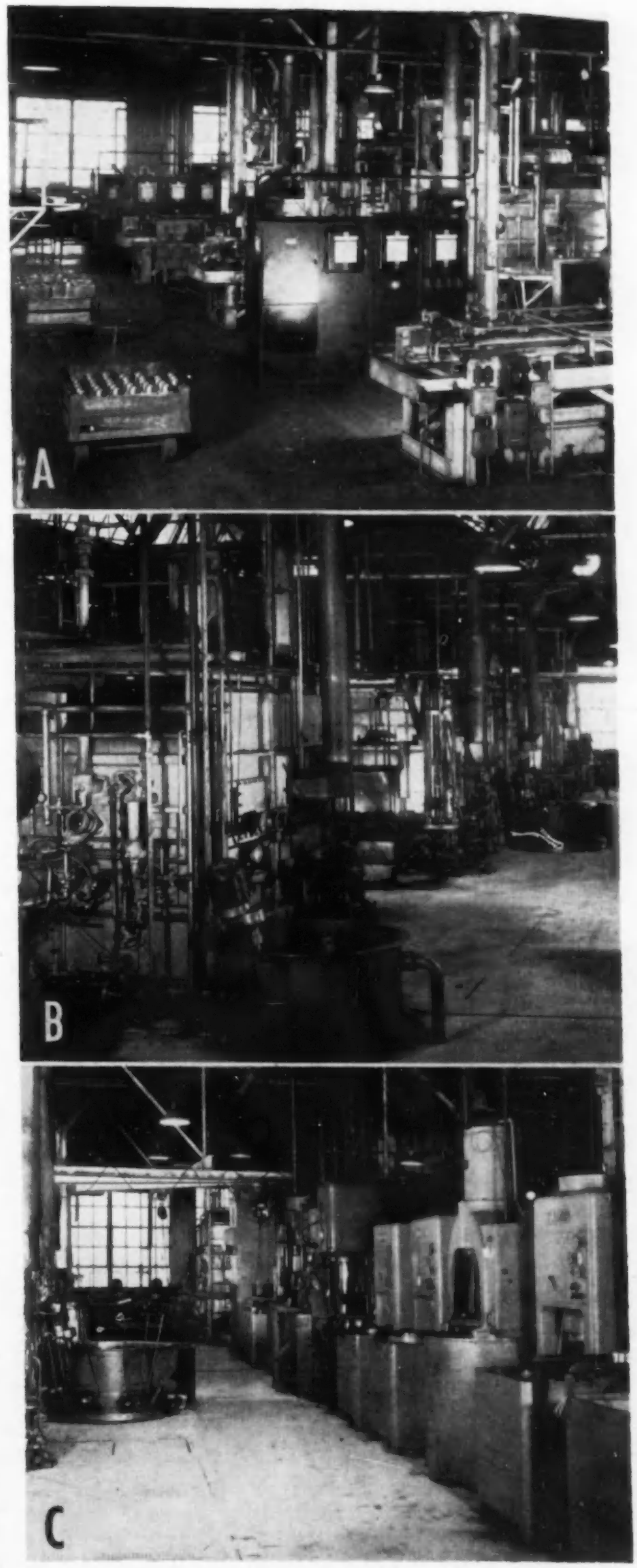


Fig. 3—Sections of the Allis-Chalmers heat-treat department. Shown in "A" are the charge ends of the continuous carburizers. Note the drag conveyor at left delivering gears to the heat-treat department. Discharge ends of the carburizers are shown in "B." The quenching presses are at the discharge end of the carburizers, pictured in "C"

Car, Truck Fleet Operators Lament

COMPLAINTS on maintenance accessibility coming from a survey of 75 fleet men operating all type vehicles—in food distribution, public utilities, over-the-road hauling, and salesman's cars—fall into three general classes:

1. The engine and its accessories are hard to get at in cab-over-engine (COE) trucks.
2. It is tough to remove and assemble engine accessories such as generators, fuel pumps, carburetors, and electrical units on both COE and conventional trucks.
3. Adjustments of brakes, steering gear, valves, clutches, and other fast-wearing items need to be made easier.

One operator who uses many COE models in city operations cited the difficulty of removing and replacing generators in one model. It was impossible to replace the generator without removing the radiator. Also, the engine cannot be worked on without removing engine cover, floor boards, and so forth, inside the cab. It was suggested that the accessories be located so that they could be worked on from above, that the screws in the floorboards should be eliminated, and that the floorboards should be fastened down with several quick-action locks.

In another make of COE, one operator reports the oil line, from engine to oil pressure gage, is very difficult to change due to inaccessibility. In the same make or model, this operator cites the following items wherein difficulty is experienced due to the inaccessibility: upper water manifold, cylinder heads, fuel pump, and generator. He mentioned the air compressor, located on the front of the engine, which requires removal of fan pulley shaft for replacement.

On another make, this same operator says the carburetor adjustment requires a special flexible screw driver or removal of the floor boards, and that the master brake cylinder has to be filled from under the truck.

Still another operator said: "On all COE models in our fleet, maintenance accessibility is a lost feature. Even installing a fan belt or spark plug becomes a problem. It would require considerable redesign to eliminate the problems involved, but well worth while, since it would let the operators enjoy the advantages of COE equipment without suffering maintenance wise".

Something can be done about inaccessibility of many parts and accessories on engines which require routine maintenance. One manufacturer recently has produced a truck with a cab which is tilted forward mechanically. Since they have found a way to tilt the cab when the battery is dead, it seems to work perfectly. As an indication of the value of this design from a maintenance standpoint, the guaranteed maintenance charges made by this company are reduced about 10% on the models incorporating the tilt cab as compared to their trucks with standard cabs. Since the vehicles have the same mechanical features, it must be assumed that this reduction is due to saving if possible in mechanical labor due to accessibility.

Removal of engines and engine accessories is plaging operators of large trucks of conventional design. One of the operators, running a large fleet of diesel engine trucks in over-the-road trucking, commented on the problem of removing the engine from the chassis for overhaul in his own shop. He said it was necessary, when removing the engine, to remove the transmission, clutch, and flywheel and to separate the cylinder block from the engine bell housing. The housing must be left fastened to the motor leg supports.

All of this work is necessary because the steering gear assembly interferes with removal of the engine as a unit. He further suggests installing the steering gear on the outside of the frame. He hastens to point out that removal of the steering gear itself with the engine in place is equally as difficult. In other words, there just isn't enough room.

Another operator using heavy-duty trucks, laments the lack of proper identification on the outside of the cylinder block regarding exhaust and inlet valves. Since the valves require different clearances, he suggests that they should be marked on the block or head to make it easy for the mechanic to identify them to avoid mistakes.

This operator criticizes the location of the cross brace between the front spring rear hangers on one make of truck. Because this brace is behind the rear motor support bracket, it is necessary to re-

EXCERPTS FROM PAPER* BY

H. O. Mathews, Manager of Transportation, Standard Brands, Inc.

*Paper "Accessibility for Maintenance—Cars and Trucks," was presented at SAE National Transportation Meeting, New York, Oct. 17, 1950.

Maintenance Inaccessibility

move the motor to replace the brace. Perhaps the operator should find out why the brace has to be replaced, since this work does not appear to be normal.

Another operator of medium and heavy-duty equipment is irked by troubles in removing and replacing radiator hose, particularly the hose at the lower end of the radiator extending to the water pump. I am surprised that more operators have not commented about this item. I am sure that any of you who have had the experience, not only lost a screw driver, several bolts and nuts, your religion, but probably lost your respect for all manufacturers of radiators.

The operator has this suggestion to make—"An elbow molded hose could be used which would eliminate the necessity of the metal elbow on the water pump." This appears to be a very simple change.

This same operator tells about the inaccessibility of the starter and fuel pump on one popular model. He also notes that the clutch throwout shaft and arm on one model are welded together, making it necessary to remove the transmission, the clutch assembly, the flywheel, and the bell housing to replace the clutch throwout shaft. He suggests that a removable arm should be designed which can be replaced easily.

The low-priced passenger cars and light-duty trucks came in for their share of constructive criticism regarding design from almost all the operators who replied to the questionnaire. Many of these comments are particularly important to all operators and manufacturers.

Outside, Inside Body Work Costly

One operator called attention to the extra cost and difficulty in repairing body and fenders on one late model passenger car. Another operator states that labor would be facilitated if: (a) fenders were detachable, and (b) if the upholstery were applied so that removal and replacement were easier—avoiding use of nails and other nonpositive attaching methods. This same operator finds it difficult to remove valves from one popular type of the same make vehicle. It is designed so that the bell housings must be removed to replace the clutch. Several other operators made this same comment. Perhaps operators will have to quit using this vehicle until a change is made. Experience indicates that this procedure has a wonderful effect.

This same operator made a very important observation concerning the equipment on the dash unit and the maze of mixed-up wiring underneath the dash, which must be repaired occasionally and which certainly is inaccessible to the ordinary mechanic. He suggests "removable panels," on either the dash or the fire board wall, to facilitate maintenance and replacement of dash units considerably. The same operator says it takes too long to remove and repair window regulators and door controls of equipment, including passenger cars. Certainly there is room for improvement in this design.

An operator of more than 1000 vehicles has this to say about a certain make of truck:

a. Oil line to rocker arm shaft is placed in a very undesirable location, and is very hard to service.

b. Very little clearance between side of cab frame and manifolds necessitates removing cylinder head simply to drill out broken manifold studs. Manifold studs crystallize very easily and seem to break off without any stress.

c. Changing of generator is a major operation as it requires removal of wheel, fender parts, and so forth.

d. Front shackle pin of rear spring is almost impossible to remove because it is built too close in and it becomes necessary to cut bracket off frame for replacement.

Another operator of light-duty equipment reports on the extra costs involved in repairs to the master brake cylinder, changing the front engine supports, replacement of freeze plugs, and replacement of water pumps on one model. Since this operator does very little work in his own shop, he is in a good position to measure the extra time required for maintenance involved in such items.

Tough-to-make adjustments, the third group of complaints found in the survey, also swell maintenance costs. For example, a fleet man operating light-duty vehicles in some rough territory in the Middle West is vexed with adjustment of anchors on one make of hydraulic brakes. He has to remove brake drums and wheels and use a special brake gage to adjust these anchors. Formerly the

anchors could be set from the backing plate and adjusted with the gage through a slot provided in the brake drum. Of course, this was much cheaper.

This reply, along the same lines, came from an Eastern Seaboard operator:

"Hand or emergency brake could stand a lot of improvement. It is either in the drive line or in the rear hub, and it seems that the manufacturers are trying to hide the brake shoes because they are of no value. Either brake is all right, if properly designed and made accessible to get at for proper adjustment and relining of shoes. Most mechanics prefer the drive shaft type because of accessibility and elimination of brake cables.

"Oil pan of the engine should be designed for easy removal and perfect gasket seals. On some vehicles, both cars and trucks, it is necessary to remove the rods, drag link, radius rod, cross member motor supports, and clutch inspection cover in order to just install an oil pan gasket. Adjustments costing 35¢ require a day's labor.

"The differential on one make would be much simpler to repair if adjusting screws were used instead of shims. This would save time in having to disassemble the whole unit just to remove one shim."

Flat Rates Reflect Accessibility

Still another approach was used to determine improvements made in design by analyzing the flat rate time allowed for certain operations on vehicles of the prewar design compared to those of the new designs made in 1948 or 1949. Two manufacturers of small vehicles very kindly consented to furnish me with information which I believe will be of value in considering this problem.

Table 1 compares the flat rate charges made by dealers in time, not in money, for the various operations selected. Since the basic mechanical design has not been changed on this particular make, it must be assumed that the changes in time required for the complete operation shown result from either a greater or less accessibility to the part to be repaired.

For example, a replacement of piston rings on the 1941 model requires 7.9 hr while 8.1 hr is required on the 1949 model. The replacement of both pistons and rings has increased from 8 to 9.6 hr. Replacement of brake shoes and overhaul of the brake master cylinder also takes more time. There are, however, a few decreases, such as a complete brake adjustment, clutch assembly overhaul, and engine overhaul.

The same items were considered by another manufacturer, shown in Table 2, to determine what he had done. Note that there is a general decrease in the flat rate time allowed in most of these items. A careful examination of the vehicles would indicate that such should be the case. Many items are more accessible because additional room has been provided. Since the labor rates for all these items were increased approximately $1.00 per hr during the period of the comparison, any increase in time would seriously affect the operating cost of the vehicle.

There is no doubt that there has been some improvement in the quality of particular items whereby the frequency of the operations might be reduced. But since some of these operations are on a routine basis in connection with any preventive maintenance schedule, a decrease in time required is of utmost importance to the operator.

These two tables do not reflect the improvement in accessibility resulting from changes in design which we believe should be reasonably expected in the period covered. Since the operators' comments included criticisms of vehicles and designs up to and including 1950 models, it is reasonable to assume that much improvement is still necessary to reduce the time required for maintenance of ordinary items on vehicles in general use.

I feel that many operators, including myself, do not spend sufficient time in the selection of vehicles to determine the accessibility of various parts which will require either routine or special maintenance. Too much attention is paid to the printed specifications and the appearance of the vehicle, and not how you can get it apart or put it back together as the occasion develops.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Table 1—Flat Rate Time in Hours for Maintenance on Car A

	1941 Model	1949-1950 Models
Front Shock Absorbers—Refill	0.5	Sealed Unit
Rear Shock Absorbers—Refill	1.0	Sealed Unit
Brakes—Complete Adjustment	2.0	1.2
Brake Shoes—(4 wheels)—Replace	2.2	2.5
Brake Main Cylinder—Overhaul	2.0	2.1
Engine Tune-up—Minor	1.5	1.7
Engine Tune-up—Major	2.4	3.0
Connecting Rod Bearings—Adjust	2.9	2.9
Piston Rings—Replace	7.9	8.1
Pistons and Rings—Replace	8.0	9.6
Engine Overhaul (in chassis)	16.3	15.1
Engine Overhaul (Major)	27.0	27.3
Radiator Hose—Replace	0.4	0.4
Clutch Assembly—Overhaul	3.5	3.3

Table 2—Flat Rate Time in Hours for Maintenance on Car B

	1941 Model	1950 Model
Front Shock Absorbers—Refill	1.0	*
Rear Shock Absorbers—Refill	0.9	*
Brakes—Complete Adjustment	2.0	1.5
Brakes Shoes (4 wheels)—Replace	3.1	2.7
Brake Master Cylinder—Overhaul	2.1	1.2
Engine Tune-up—Minor	0.9	0.9
Engine Tune-up—Major	1.7	1.7
Connecting Rod Bearings—Replace	3.1	3.1
Piston Rings (All Pistons)—Replace	6.2	5.1
Piston Assemblies and Rings (All Pistons)—Replace	7.1	7.1
Engine Overhaul	27.5	25.5
Radiator Hoses (all)—Replace	0.6	0.9
Clutch Assembly—Overhaul	3.6	3.5

* Not listed as an operation

WHAT'S THE FUTURE OF AIR TRANSPORT?

EXCERPTS FROM PAPER* BY

K. R. Ferguson, Vice-President, Northwest Airlines, Inc.

*Paper, "Air Transportation and What Is the Technical Future," was presented at the SAE National Aeronautical Meeting, Los Angeles, Sept. 29, 1950.

ONE way of predicting the future is to review the trend established by past events. During the past four years a number of postwar airline aircraft were introduced. Let us briefly review the record which has resulted from the technical advancement of the aircraft and airline industries.

1. Speed—Aerodynamic and power plant design advancement has resulted in airline timetable schedules that with possibly the exception of the extremely short-distance flights provide a distinct and growing advantage over other forms of transportation. This exception paradoxically can be attributed to the high-speed airplane with longer runway requirements, which is one of the causes for airports being located further from downtown districts. Thus, the airline traveler spends more time in traveling to and from the airports than he does in the air, consequently, surface transportation can better the time of the airlines for some of these short trips.

2. Passenger comfort—Considering the space and weight restrictions and the reduced time in transit, the airline passenger today travels in fair comfort. A rating no better than fair can be given because we still subject our passengers to excessive noise and vibration.

3. Operating costs—High operating costs have plagued the airlines, especially during the first several years of operation of new type aircraft. These have manifested themselves in financial statements showing losses or very meager profits.

4. Schedule reliability—Recent actual records show that on-time arrival at destination is achieved less than 75% of the time. Seasonally, this drops to as low as 50% for some airlines. The record leaves much to be desired.

5. Safety—The fatality rate has been steadily reduced, however, concerted effort to increase safety must be continued.

New traffic generated from higher speeds and greater comfort will be small in comparison to that which can be generated by improvements in the other factors.

Technical Aspects

Let us examine, therefore, the technical aspects that will provide minimum operating cost, maximum schedule reliability, and maximum safety:

Minimum Operating Costs—In discussing operating costs the following are to be considered: fuel and oil costs, flight crew costs, maintenance labor and material costs, and those usually referred to as indirect costs, consisting of the purchase and maintenance of ground equipment and facilities and the wages of ground handling personnel.

Overall aerodynamic design and choice of powerplant dictate fuel and oil costs, but let me emphasize the need for achieving minimum fuel and oil costs, since they represent a sizable portion of the aggregate operating costs.

Flight crew costs must be held to a minimum by holding the number of flight crew members to a minimum. Since the number of crew members must necessarily be dictated by safety and not economics, this matter will be discussed under safety, however, flight crew costs are a part of operating costs.

Maintenance labor and material costs are affected by durability, accessability, interchangeability, and simplicity; therefore, emphasis should be given to these factors when designing to achieve minimum operating costs.

The lack of durability results in maintenance labor and material costs of considerable magnitude.

Frequent repair and replacement of light skin, ducting, and support structure as a result of fatigue failures point to the need for supplementing existing stress analysis procedures to take cognizance of vibration forces.

The trend to add many new accessories has resulted in a tremendous increase in the number of units which must be removed from aircraft for scheduled overhaul. Thus, the cost entailed in removal, overhaul, reinstallation, and handling takes on large proportions. Greater durability of these units will permit longer periods of operation between intervals of overhaul with reduction in cost.

Perhaps more influential in the reduction of operating costs is simplicity, but I'm afraid that our recent aircraft have tended toward the opposite, complexity. I also realize that in endeavoring to obtain minimum weight, complexity is often the result. This is not meant as criticism, for I merely wish to point out that our future designs must take cognizance of the fact that complexity means more exposure to failures and malfunctions, more labor and material costs, more training for flight and ground personnel, and the requirement for higher caliber personnel, with resultant higher wages. I sincerely suggest that our designers ask themselves the question, "Is this gadget necessary and how can I simplify this design?" before final approval is given.

Accessibility

Accessibility for inspection and maintenance cannot be over emphasized in striving for lower operating costs. The labor and time expended by the airlines in reaching accessories, controls, and structure in order to perform required maintenance has a most unfavorable effect on maintenance costs.

The lack of interchangeability contributes to high maintenance costs. The actual job of replacing a part once the obstructions are moved is simple except for the job of fittiing, trimming, and "persuasively forcing" the new part into place. I know that the aircraft manufacturer immediately visualizes his costs for fixtures and jigs going beyond reason when the word interchangeability is mentioned. However, I believe he should give proper consideration to the many hours of labor which can be saved by interchangeability when assembly and installation are being made in the factory.

The configuration of the future airline aircraft could help considerably in achieving low operating costs, in which is included the cost of ground equipment, its maintenance, and the wages of ground handling personnel. Our aircraft of today require elaborate passenger ramps and cargo handling equipment because of the excessive height of the fuselage above the ground. A high-wing airplane with fuselage in close proximity to the ground would eliminate the need for large, expensive ramp equipment, and would reduce ground handling labor and time at the station. A design of this type would permit the main landing gear to be recessed in the fuselage with a good chance of completely eliminating mechanisms for lowering and raising the landing gear. Please bear in mind that these mechanisms require maintenance. Minimum distance between the fuselage and the ground will also permit lower hanger ceiling height, which means that hanger costs, heating requirements, and upkeep will be less.

Schedule Reliability—One of the requirements for any form of successful transportation, is the assurance the customer will arrive at his destination at the scheduled time. If he does not, value has not been received and he is not satisfied. Factors which affect schedule reliability and which should be given consideration in future design are automatic approach equipment to permit fully automatic approaches, improved airplane maneuverability at low speeds, accessibility and durability of aircraft components, airplane simplification, and more liberal center of gravity limitations.

Two of the obstacles to achieving good schedule reliability are, of course, low ceilings and poor visibility. A means of permitting operation under lower minimums will be by automatic flight equipment designed to permit regular use in conjunction with ground navigational aids.

In order to achieve automatic approaches under poor weather conditions, highly refined compatability between the automatic pilot and the aircraft, will be necessary.

The need for holding minimum flying speed as low as possible, the achievement of maximum maneuverability and stability at low speed, and good flight handling characteristics at low speed are essential in arriving at the goal of all-weather flying. The ability to land an aircraft under low visibility and ceiling conditions is directly dependent on these factors.

There is, perhaps, nothing that disturbs the airline passenger more than the last-minute announcement that a delay will be involved because a breakdown of a system or unit has occurred. Here again, accessability plays an important part in attaining the highest possible schedule reliability. The design of future aircraft must reflect the fact that components and accessories, no matter how well designed, will always fail "off schedule," and therefore, quick replacement is necessary in order to maintain schedule. Durability of aircraft accessories and components plays an important part in achieving schedule reliability.

Simplification of systems can also provide better schedule reliability. Obviously, the more simple the system, the less time required for trouble shooting to determine corrective action necessary. It is recognized that this cannot always be done, and unfortunately this usually requires the trouble shooter to cover the airplane from stem to stern. It is suggested, for example, that consideration be given to the use of test panels conveniently located to permit a complete checkout of the electrical system.

Improved Methods of Loading

More streamlined methods of loading and control of center of gravity are vitally needed if we are to succeed in our effort to attain better schedule reliability. There will always be the need for expeditious handling of cargo on passenger aircraft on routes where an all-cargo airplane cannot be justified and for the handling of baggage, mail, and rush shipments of freight. Here again the low fuselage to facilitate cargo handling comes into the picture. Large cargo doors to permit expeditious handling of

cargo, so located as to prevent conflict between cargo handling and other ramp activities, along with mechanized equipment to handle cargo within the compartments, must also be considered.

One of the causes for delays is the last-minute arrival of passengers and/or cargo, which often requires that the center-of-gravity location be redetermined to ascertain that the added load has not caused the c.g. to fall outside the certificated limits. Unfortunately, if it does, cargo must be shifted, usually resulting in delay. This problem can be alleviated by the designer striving for wider c.g. limits when the aircraft is in the preliminary design stage.

Safety—Probably the foremost safety topic, and the one that has received the most attention from a regulatory standpoint, is fire prevention, detection, and protection. It is my belief that greatest progress can be made toward preventing the spread of fire and confining the damage to the source of the fire. Means must be developed that will positively prevent fire in flight from damaging primary structure and primary controls. This is based on the philosophy that absolute prevention of fires is impossible, the 100% reliability of the detection system cannot be achieved, and that completely reliable extinguishment of all fires can never be assured. Future designs should give us powerplant, fuel plumbing, oil hydraulic installations, and heater installations which can burn to complete destruction without spread of the fire to wing, fuselage, or landing gear structure. In this connection complete adoption of steel for primary structure, the adoption of fireproof coatings, panels, or shrouding should receive serious consideration.

Gust Alleviation

Gust alleviation should receive the industry's foremost consideration to achieve improved flight control, reduction of structural loads and, last but not least, the alleviation of the poor passenger's apprehension. Therefore, lift curves for airfoils contemplated for new aircraft should include consideration for minimum rate of change of lift with change of effective angle of attack in the cruise range. This may require the use of supplementing control from existing surface controls, possibly the design of an additional control for the specific purpose of gust alleviation, or ingenuity of structural design could permit flexure of the wing to provide a variable and compensating angle of attack in turbulent air. The choice of an airfoil that provides minimum change in lift coefficient with change in angle of attack in the cruise range should not be overlooked as the most simple solution to this problem. . In the event gust alleviation cannot be achieved to a considerable degree, it is my recommendation that ultimate load factors be increased upward approximately 25% to alleviate pilot and passenger apprehension.

The cockpit of today's modern aircraft is a maze of switches, indicators, warning lights, and controls. I believe we have exceeded the saturation point of the flight crew's ability to comprehend, analytically at least, and certainly beyond their capacity to develop an automatic reaction pattern to, every combination of indications and circumstances. Complexity also results in the addition of many steps in the procedures for combating emergency circumstances to the point where the ability of the pilot to accomplish these procedures within a safe interval of time is jeopardized. Fundamentally, this is not sound since a clear understanding of the indications and control functions and the ability to take corrective steps immediately and automatically is necessary to achieve the ultimate in efficient and safe operation of the aircraft.

Consistent with the objective of simplicity is the adoption of a central power and control room accessible in flight and in which would be located equipment such as electrical, heating, air conditioning, ice prevention, and the associated control for this equipment. Power for driving this equipment would be supplied by independent units. Briefly, the advantages would be (1) lower maintenances costs due to the elimination of circuitous plumbing and wiring between engines and fuselage, which will result in less maintenance; (2) greater schedule reliability due to the ability to trouble-shoot a major portion of a system in one location, plus the ability to perform in-flight maintenance on components and accessories heretofore not accessible in flight; (3) greater safety, occasioned by the relocation of generators, alternators, hydraulic pumps, and vacuum pumps from the engine to the central power room—thus eliminating one of the common causes of engine fires. Elimination of long lengths of wiring and hydraulic plumbing from the engines to the fuselage will reduce the number of electrical and hydraulic fires. Location of these units in the fuselage, where they can be closely monitored by a member of the flight crew, will assure the aircraft of an uninterrupted supply of vitally required energy sources.

Previously, I mentioned the need for keeping the number of flight crew members to a minimum—in order to achieve lowest possible operating costs. Actually, the trend has been in the other direction, which, I believe, has been motivated by complexity and the feeling that additional eyes and hands in the cockpit were necessary to achieve safety. An additional flight crew member can pay his way; however, if he has been added merely because of the complexity of the aircraft, his economic justification is questionable.

The elimination of gadgetry required to perform primary safety functions is a worth-while objective. The ability to feather a propeller, for example, should not be lost by the numerous potential failures inherent in a goodly number of relays, time delay switches intermeshed with circuitous wiring. I have merely chosen this an an example of how we can be misguided in achieving the ultimate in safety when gadgetry and complexity are used in place of straightforward engineering analysis.

In the foregoing, I have attempted to touch on some of the objectives that should be included in the design of future air transport. In order to achieve these objectives, I want to urge a high degree of cooperation between the aircraft manufacturers and the airlines so that a better understanding of each other's problems can be had.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

1. More Load Capacity

2. Longer Life

3. Sufficient Speed

WHAT OPERATORS WANT

MORE economical operation of earthmoving trucks on the Mesabi iron range hinges on three requirements: greater load-carrying capacity, dependability, and speed. Iron mining operators need units capable of carrying at least 30 long tons. They want longer life designed into hoist systems, steering systems, brake systems, transmissions, rear ends, and auxiliary apparatus. And for desired speed, the engine should deliver 13 to 15 hp per ton of load.

What the future will bring in large capacity trucks is still indefinite. But two 40-ton experimental haulage units tested taught both mining companies and manufacturers a great deal.

The first was a 40-ton truck with a tandem axle, 6×4. The drive tires were $16{:}00 \times 32$ and the front tires were $18{:}00 \times 24$. A 550-hp, supercharged 12-cyl diesel powered the vehicle. Both chassis and engine were experimental. On the road this truck carried about 120% more dirt per hour than the 20-ton standard truck. Many features on the present 30-ton truck can be traced back to this 40-ton job.

The second 40-ton unit tested was a 4×2. It was really a single-axle tractor and a single-axle trailer. All four wheels had $27{:}00 \times 33$ tires. The powerplant was a converted 12-cyl, naturally aspirated aircraft engine burning butane. Although the engine was highly dependable, the rest of the unit gave some trouble.

But high load-carrying capacities are no asset unless the trucks are running. That's why dependability is the mining operator's next most important need. The average mine truck is available for only 63% of the time, and out for repairs the other 27%. Many more trips are lost because of small repairs than from major breakdowns.

Little Troubles Are Big Headaches

When a driver experiences a serious failure, he takes another truck if available. But he usually waits for small repairs. Traveling back to the garage for these small repairs or adjustment causes the high production loss. A truck stopping for radiator water may lose only one trip; but that is 3 to 4% of the shift's production. Time out for a clutch adjustment costs at least four trips. Productivity suffers a serious blow when a fleet of 10 trucks returns to the repair garage 300 times in one month for minor repairs. Although lax maintenance may account for some of this, much equipment cries for redesign to eliminate these small repairs and adjustments.

Here are just a few of the items causing these small delays:

Leaks in the hoist oil system are a case in point. They stem from worn cylinder packing, ruptured flexible hoses, worn hoist pump seals, and broken pipe fittings.

Flat tires also stand high on the list. On dual-tired axles, 70% of the flats occur on the inside tires. They usually go flat because of valve extension failures, a sore spot for many years. Not only does it take time to change the tire, but the tube repair necessary to replace a torn-out valve stem is costly. Perhaps a 5-deg tapered rim will prevent loss of valve stems in flat tires.

Source of steering booster troubles usually is found in leaky hydraulic lines, misadjustments, scored pumps, stuck valves, and bent rods.

Electrical system failures come from a combination of a 12-v lighting load and a 24-v starting motor load. Headlights on mining trucks last about a month, or 500 hr. Mechanical starters are being tested and, if successful, may replace electrical starting systems.

Most of the trucks are piped with copper tube air lines. Though clipped and evenly supported, these tubes work-harden and fail. All copper tubing now is being replaced with flexible rubber hose.

Most torque converters develop seal leaks, which can add up to a considerable maintenance item. For example, one 10-truck fleet used 1275 gal converter make-up oil in one month. These 10 trucks should have used only about 200 gal. Some way should be found to stop this leakage, or at least control it so that the oil can be routed back into the hydraulic system.

Major part failures and inadequacies also take their toll in yardage moved, and are even more costly than small items from a maintenance stand-

BASED ON PAPER* BY

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* Paper "Earthmoving Equipment Design from the User's Point of View," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 13, 1950.

IN ORE-MOVING TRUCKS

point. For example, the power train should have a hydraulic cushion to eliminate shock loadings to cut down breakdowns in the drive system. The transmission should be automatic or quick shift. Failure rates of transmissions, rear ends, truck frames, and front axle spindles, and short brake lining life points to need for beefing up these parts.

Transmission failures have been high, their repairs expensive. In the first half of 1950 we repaired 115 transmission for a fleet of 103 trucks. Repairs averaged about $285 per transmission. About 90% of these failures came from shock loading. Disassembly of most transmissions disclosed broken main shafts or shucked gear teeth. Occasionally worn jaw clutches or worn bearings necessitated a transmission repair. These high replacement figures make clear the need for transmission redesign or a protective device.

Drivers handle clutch and throttle improperly. That's what induces shock loading responsible for most of the transmission failures. Average clutch facing lasts about 1500 hr. In this type haulage, the driver must change gears 25 to 30 times per hour. Sometimes he makes a miscue and subjects the clutch to severe strain and slippage. This takes its toll of transmission life. This continual disengagement eventually burns up the crankshaft thrust bearing.

Shock loading is to blame too for most of the 71 rear end failures on 121 trucks in the first six months of 1950. The bearings in most of these rear ends had excessive thrust wear.

To prevent shock loadings and as an answer to our grade problems, we have experimented with torque converters. Our first converter installation was made about two years ago. Since then we made four more converter field installations and purchased 19 trucks equipped with converters. Four different converter manufacturers are represented among these units. Thirty five of the converters are single stage and five are multiple stage. These converters still are in the development stage and the best converter type has not yet been established.

If conventional transmissions continue to be used for mining work, they should have as evenly spaced ratios as possible. Shifting up or down through the ratios should be progressive with an auxiliary gear box, minimizing need for double shifting. In fact, double shifting should be eliminated both to reduce driver fatigue and to prevent missed shifts.

High failure rates also have plagued front axle spindles. During the first half of 1950, 48 spindles were replaced on 103 trucks. These spindles usually break through the fillet in the base of the boss, where it joins the yoke. Spindles also break between the yoke ears.

The change from cast to forged steel has materially reduced these failures. Shot peening the fillets also has helped the situation. Perhaps increasing spindle size at the bearing seat would completely stop spindle breakage. Any additional bearing size also would help. Bearings are found partially failed and are replaced when relining front wheel brakes or when inspecting bearings. Perhaps front axle loadings are too high for present bearings.

Earthmoving Tough on Truck Frames

Truck frames suffer structural failures. Increasing load-carrying capacities demand larger truck frames. These frames must be flexible enough to withstand occasional severe racking. Stress concentrations around torque tubes should be distributed over a wide area to reduce unit loadings. .

Most truck frames fail about 2 ft behind the cab. These cracks usually start from the top rail and work downward. Frames fail more often in cold weather. Cold strength of steel frames become highly important in operating temperatures between -20 and -40 F. And holes in the frames supporting rotating parts should be bushed with either case-hardened or heat-treated high carbon bushings. Building up out-of-round holes by welding or reboring is an expensive job.

Brake linings fail to meet the performance and life requirements of this type service. Brake lining facings should be made of fairly hard, high friction material. With trucks operating in water, the softer shoe does not give the braking effort to hold the vehicles on a steep grade. And the mixture of iron ore and water wear away the softer shoe faster. A set of brake linings should last at least 6000 hr in

Concluded on Pago 70

New "Common Denominators" Yield

COMMERCIAL engines of any given class are surprisingly similar in both important dimensional ratios and performance parameters, regardless of size or design variations. This similitude offers a good analytical tool for studying engines.

Importance of stress limitations—including bearing pressures—in determining reliability and durability is such that rated maximum piston speed and mean effective pressure tend to be the same for commercial engines of a given class. This is shown in Fig. 1, a plot of rated bmep versus rated piston speed for a wide variety of engines. Lines of constant horsepower per square inch of piston area are included in the plot.

Note that engines designed for a given service tend to group themselves in relatively small areas on this chart. Largest spread is in the diesel engine group. Here design objectives vary over a wide range and design practice is not so weii crystallized as with spark-ignition engines.

Maximum bmep and piston speed tend to be constant and independent of size. That is why maximum power output tends to be proportional to piston area rather than to piston displacement for engines designed for a given service. For American diesel engines, for example, the spread of ratings on the basis of piston displacement is ten times the spread on the basis of piston area.

It becomes apparent that the following parameters are appropriate for comparing performance

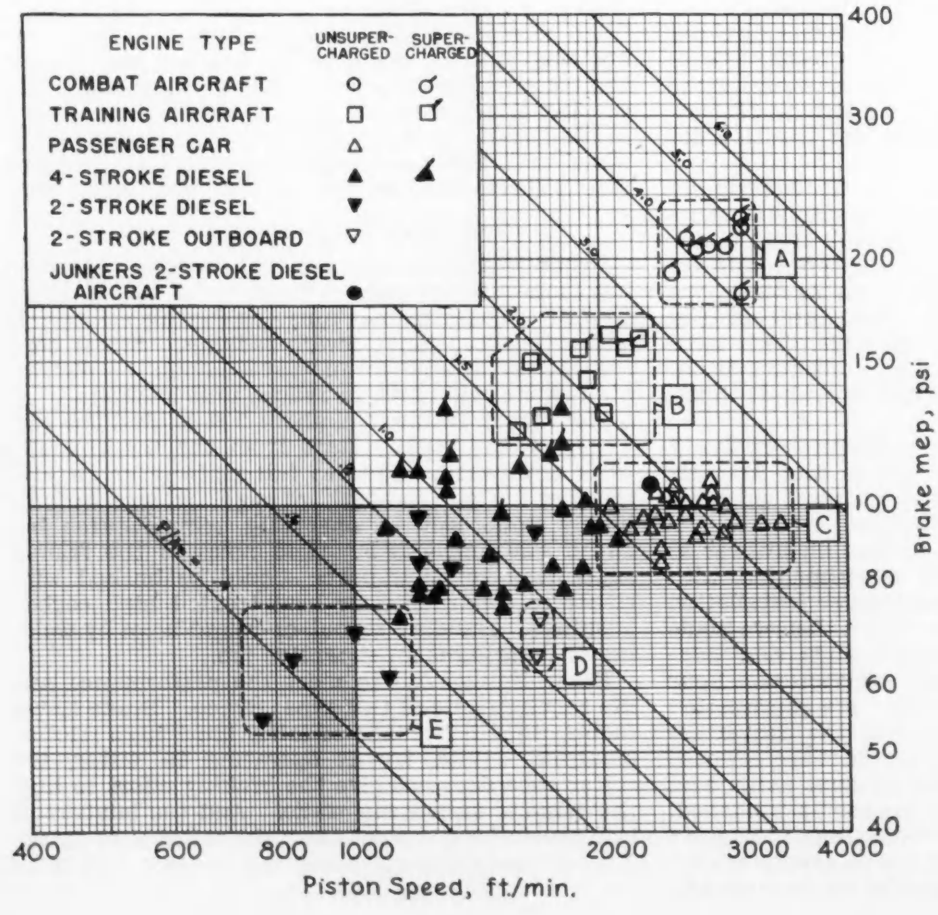


Fig. 1—Rated brake mean effective pressure, piston speed, and power per square inch piston area of various type engines. Group A consists of combat aircraft engines; group B—training aircraft engines; group C—passenger car engines; group D—outboard marine engines; group E—heavy-duty diesel engines. Remaining points are for miscellaneous diesel engines, including locomotive and automotive types

Significant Engine Comparisons

EXCERPTS FROM PAPER* BY

C. Fayette Taylor

Professor of Automotive Engineering, Massachusetts Institute of Technology

* Paper "The Correlation and Presentation of Diesel Engine Performance," was presented at SAE National West Coast Meeting, Los Angeles, Aug. 14, 1950. This paper will be printed in full in SAE Quarterly Transactions

of internal combustion engines when measures of quality independent of cylinder size are desired:

- Mean effective pressure, brake and indicated.
- Mean piston speed.
- Power per unit piston area.
- Weight per unit piston displacement.
- Thermal efficiency.

Figs. 2 and 3 are plots of brake mean effective pressure and piston speed against bore for American diesel engines, based on manufacturers' maximum ratings. The curves have been drawn to show the trend of the groups as a whole; where no trend is evident, they have been drawn parallel to the other curves. Position of any particular engine, with reference to the line for its group, immediately indicates whether it is above or below average in this particular respect.

Variation in combustion chamber design is partly responsible for the spread in the automotive group. With similar combustion chambers, the points probably would fall closer together. The mep of the supercharged engines is especially interesting, since here the limitation is set by considerations of reliability and durability only.

The downward trend of bmep and piston speed

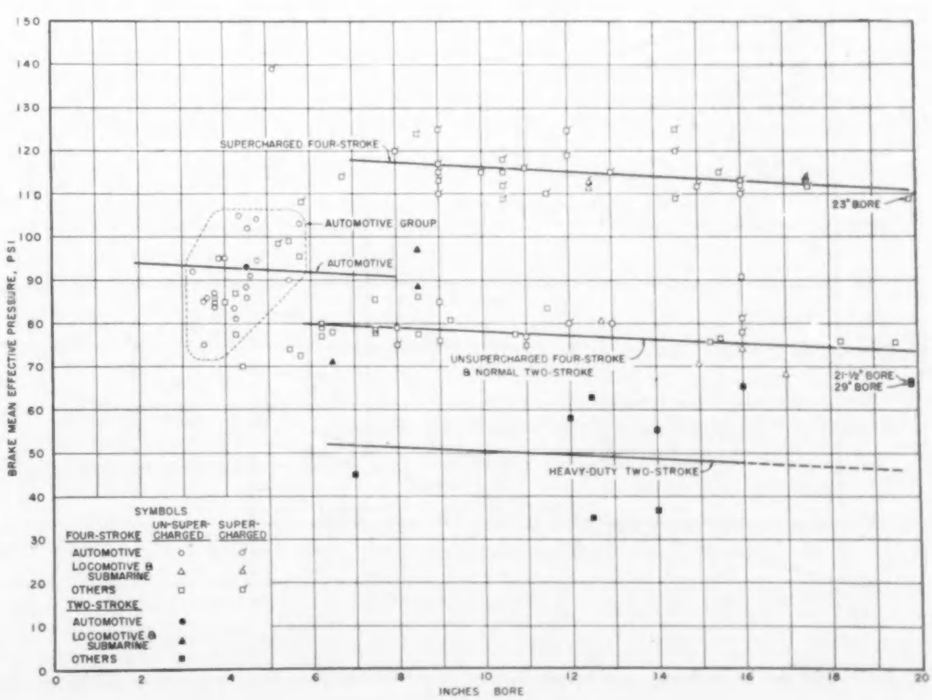


Fig. 2—Rated brake mean effective pressure versus bore of representative American compression-ignition engines. (Data from Diesel Power and Diesel Transportation, April, 1947.)

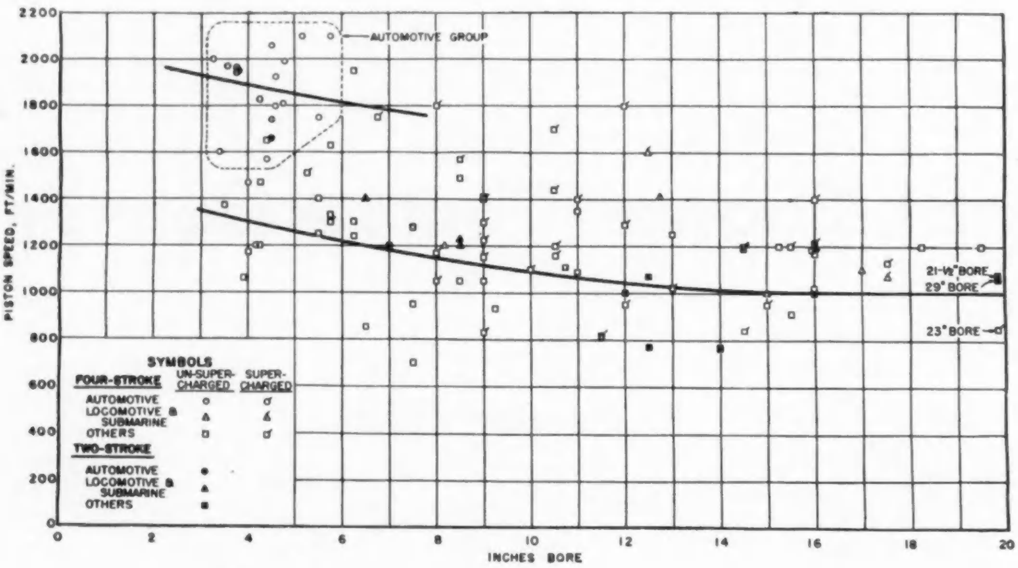


Fig. 3—Piston speed at rated power versus bore of representative American compression-ignition engines. (Data from Diesel Power and Diesel Transportation, April, 1947.)

with increasing bore is less than might be expected, considering that, as bore increases:

a. Development work is increasingly expensive, and less of it is done.

b. Failures are more costly, and ratings must be increasingly conservative.

c. Service requirements tend more toward long life and great reliability, which should lead to conservative ratings.

d. Temperature stresses are higher.

Fig. 4 shows that weight-per-rated-horsepower of American diesel engines increases with bore, as theory predicts. While maximum output is nearly proportional to the square of the dimension, weight is more nearly proportional to the cube of the dimension. The average curve shows weight-per-horsepower proportional to the bore, as would be the case with similar engines. Departures from this curve give an excellent indication of whether a design is light or heavy for its cylinder size.

These considerations lead to a method of plotting performance of a given engine which is extremely useful. It is to plot brake mean effective pressure as ordinate, piston speed as abscissa, with lines of constant specific fuel consumption, and line of constant power output per square inch piston area.

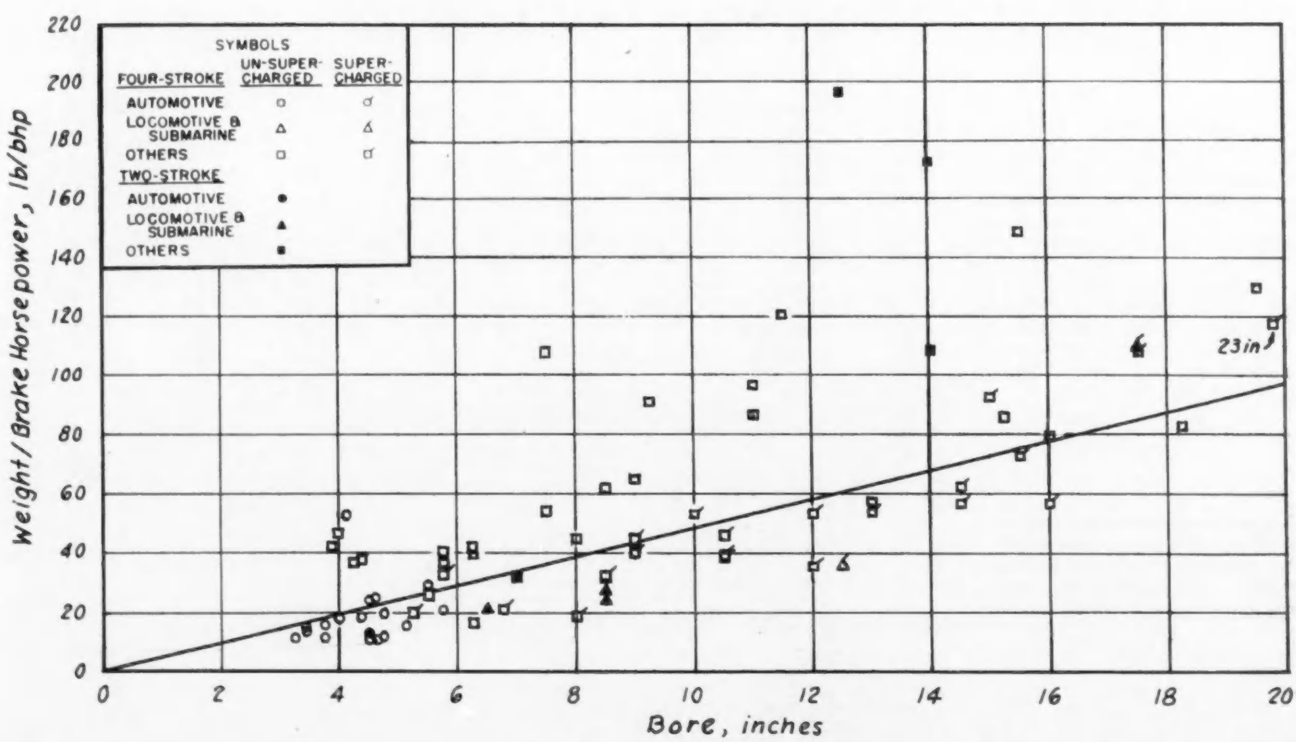


Fig. 4—Weight per brake horsepower versus bore of representative American compression-ignition engines. (Data from Diesel Power and Diesel Transportation, April, 1947.)

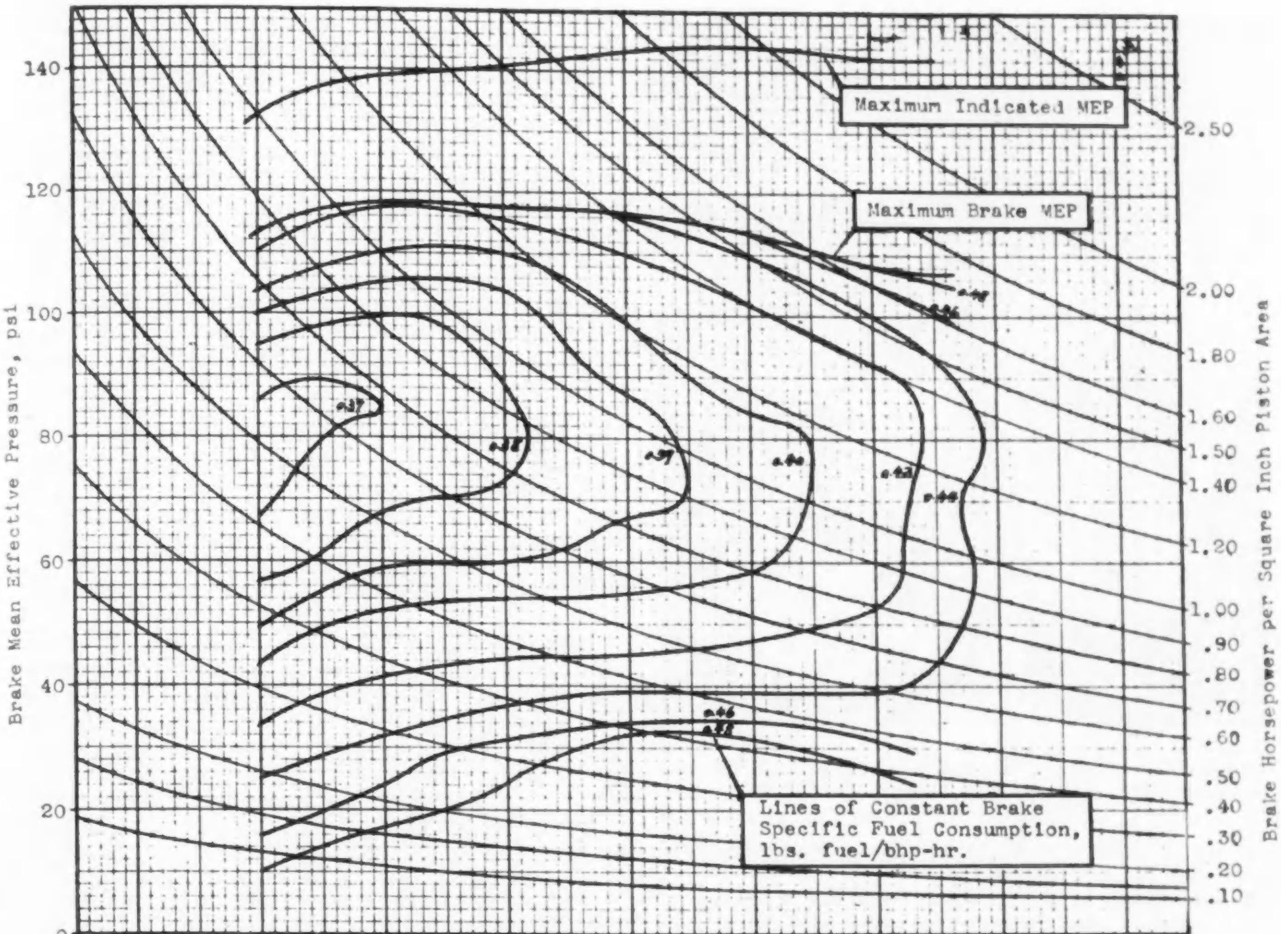


Fig. 5—This type of plot tells the story of a given engine's performance in a nutshell. Performance curves here are for a four-stroke, pre-chamber, 6-cyl diesel engine with a 5¾ × 6-in. bore and stroke

Such a chart, Fig. 5, gives a complete story of engine performance on one sheet. It can be compared with similar plots of other engines, regardless of cylinder size or number of cylinders.

General shape of the fuel consumption lines is characteristic of all normal engines, either gasoline or diesel. With rare exceptions, the point of lowest specific fuel consumption is in the left-hand upper part of the chart—at relatively low piston speed and relatively high mean effective pressure. This point occurs at low piston speed—because friction mean effective pressure is low, and at high mep—because here mechanical efficiency is high.

If the efficiency drops off at lower speeds, it is because of poor distribution or injection characteristics. At mep's higher than that for best economy, thermal efficiency falls off due to increasing fuel-air ratio.

If one is interested in performance of a particular engine rather than comparing with other engines, the scales of Fig. 5 could be changed by substituting torque for bmep and rpm for piston speed. Instead of lines of constant horsepower per square inch piston area, lines of constant horsepower could be used.

Table 1—Performance Parameters of the Arden Model Airplane Engine and Nordberg Diesel Engine

	Arden (Power Peak)	Nordberg (Maximum Rating)
Brake mean effective pressure, psi	47	66
Piston speed, fpm	980	1100
Horsepower per square inch piston area	0.71	1.07
Weight per cubic inch displacement	3.78*	2.95

* Corrected to cast iron instead of aluminum cylinder and crankcase.

Table 2—Specifications of the Arden Model Airplane Engine and Nordberg Diesel Engine

	Arden	Nordberg
Maximum horsepower per cylinder	0.136	710.0
Piston displacement, cu in.	0.10	26,500.0
Weight per cylinder, corrected to same materials, lb	0.38	78,000.0
Horsepower per cubic inch displacement	1.36	0.027
Weight per horsepower, lb	2.8	110.0

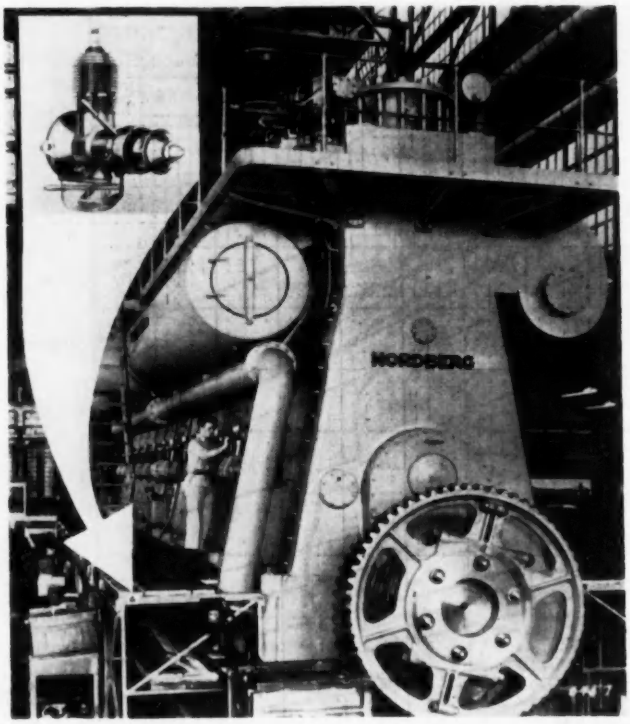


Fig. 6—Laws of similitude hold true even in comparing the 0.136-hp Arden model airplane engine that displaces 0.10 cu in. (upper left-hand corner) with the 8000-hp Nordberg stationary diesel of 26,500-cu in. displacement

And total fuel consumption curves could replace specific fuel consumption.

The more general method of plotting is especially attractive to the engine designer because mean effective pressure and piston speed are universal measures nearly independent of engine size, but very dependent on engine design. Thus the theory of engine similitude affords an extremely powerful tool which seems to have been neglected. With appropriate modifications, the theory can be applied to other types of machinery.

Even with engines of widely different conception, laws of similitude can easily be recognized. For example, Fig. 6 shows the largest engine on which we have performance data and the smallest. The large one is the Nordberg 8000-hp, 29-in. bore, two-stroke, loop-scavenged diesel engine. The small one is the Arden ½-in. bore model airplane engine; it too is a two-stroke, loop-scaveneged compression-ignition engine, although it does not use fuel injection.

Test data on the Nordberg were available from the manufacturer. For the small engine, it was necessary to run performance tests on a specially-designed dynamometer.

Note that the performance figures for the two engines in Table 1 are roughly the same, as theory would predict. But contrast them with the performance specifications for the two engines in Table 2.

These data shows that power per cubic inch displacement and weight per horsepower are improper measurements of engine quality when dealing with engines of widely differing cylinder size. The data in Table 1 give useful comparisons of the two engines, despite the almost astronomic difference in their size. Obviously performance of the Nordberg is somewhat better than that of the Arden, as would be expected in view of little emphasis on high performance required for a model airplane engine.

(Paper on which this abridgement is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

WHAT OPERATORS WANT IN ORE-MOVING TRUCKS

Continued from Page 65

normal use, but now hold up for only 3000 hr.

Brake drums should be large enough to dissipate heat fast enough to prevent tire flap failures. Truck drivers tend to use the hand or emergency brake for an application brake. The feeling of insecurity in backing up to the edge of a 50 to 100-ft high dump makes drivers use hand brakes to control vehicle speed. With 35 to 40 such stops per 8-hr shift, hand brakes soon wear out.

The air assist feature on the hand brakes is used to control the rear axle air brakes. It might help to install a trailer brake valve on the truck steering column, connected so that it would operate only the rear axle brakes. Then the drivers would use this brake instead of the hand brake for controlling vehicle speed while backing up.

Among the other design inadequacies found in earthmoving trucks are: inaccessible engine installations; lack of large capacity cab heaters; uncomfortable driver seating arrangements; not heavy enough wear plates; and short-lived engine temperature control devices.

Speed is the earthmoving equipment operator's third need. A truck should have enough horsepower to give it snappy performance on grade work. A haulage truck should be able to travel up an 8% grade, with its full rated load, at about 10 to 21 mph. These trucks should be so geared that they have a maximum top speed of 30 mph when returning empty to the pit.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

We *Can* Quiet Trucks!

BASED ON PAPER* BY

Ernest J. Abbott, President, Physicists Research Co.

* Paper "Why Not Quiet Those Trucks?" was presented at SAE National Transportation Meeting, New York, Oct. 16, 1950.

HUMAN inertia is a tougher nut to crack than the technical problems in quieting truck exhaust noise. Truck builder, muffler maker, and fleet operator all agree exhaust noise is serious enough to do something about, but each insists the other fellow is to blame. Actually a well-designed 5-cu ft muffler, instead of the 1-cu ft devices, can turn the trick without penalizing either performance or costs.

Few if any of 200-hp and larger vehicles are furnished with adequate exhaust muffling by the original manufacturer. They are serious offenders from the start. (See Fig. 1.)

Measurements and observations were made of the noise of hundreds of vehicles operated on highways, some run specifically for test, others in normal road traffic. Several sample mufflers were tested. Trucks operating on hills and under other full-throttle conditions were found to be 10 to 100 times as loud as passenger cars. (See Fig. 2.) The larger size and power of a truck makes it seem reasonable for trucks to be two or three times as noisy as passenger cars. But above this, truck noise is objectionable and needless.

Muffler cut-outs on passenger cars long have been outlawed in most places. Starting with a louder noise, most trucks have little more muffler than a passenger car with the cut-out open.

None of the higher-powered trucks is regularly equipped with mufflers that can cut exhaust noise to three times that of passenger cars. Adequate vehicle quieting calls for better mufflers on all new vehicles and their use as replacements on present vehicles. Since current muffler-designs often have a relatively short life, the change-over could be made at small cost at replacement time.

Some operators say they want to buy trucks with better mufflers, but cannot get them. Vehicle manufacturers claim no one would buy such trucks. They maintain operators will not accept the power loss inherent in muffling, that mufflers presently supplied are promptly disembowled. Muffler manufacturers assert that vehicle builders will not buy adequate mufflers or allow room to install them.

Designing a muffler that diminishes exhaust noise to tolerable levels is not an insurmountable problem, if the muffler is made large enough. There is also a practical way of making room for them, the cab roof, for instance.

Assuming competent muffler design, the question is mainly one of cubic feet. Recent tests show that a muffler volume of about 5 cu ft gives satisfactory quieting and low-back pressure on high-powered trucks. For low back pressure on a 250 to 300-hp engine, a $4\frac{1}{2}$ to 5-in. diameter exhaust pipe is an

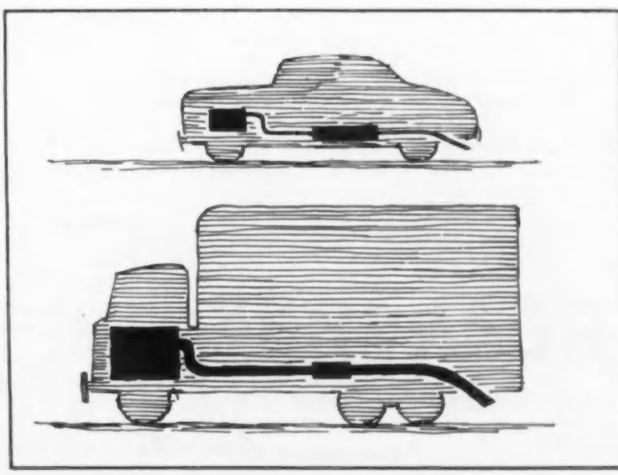


Fig. 1—Today's trucks, with powerful engines and large-diameter exhaust pipes have tiny, ineffective mufflers. Yet passenger cars, with much smaller engines and exhaust pipes, have larger and highly effective mufflers

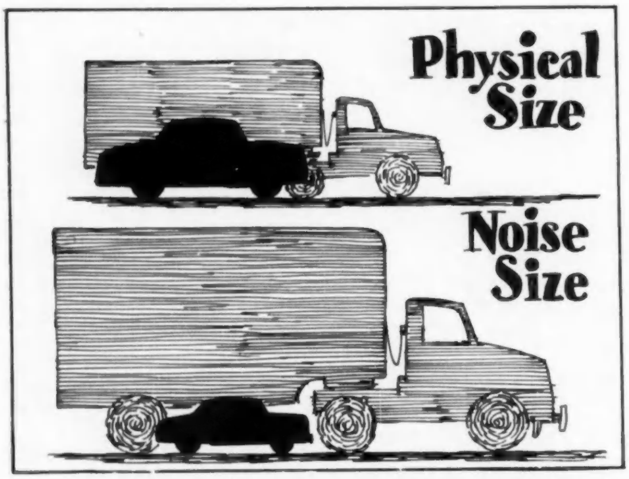


Fig. 2—Compared to passenger cars, trucks operating at full throttle have two to five times the power, yet emit 10 to 100 times as much noise. Most of this is exhaust noise

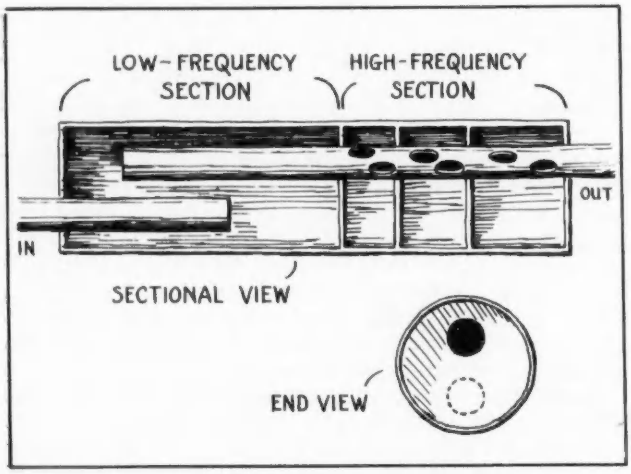


Fig. 3—Effective muffler design calls for a low-frequency chamber of adequate volume to smooth out the roar, and one or more high-frequency chambers, especially for diesels. To be satisfactory, truck mufflers must be about 12 to 14 in. OD and 5 to 6 ft long

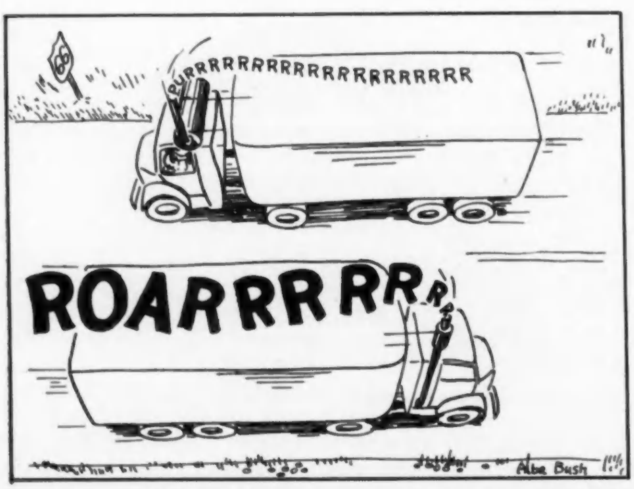


Fig. 4—Top-of-cab installation is one way of solving the space-finding problem for an adequate size truck muffler

economy. Sharp bends and shoulders should be avoided. One of these can cause more back pressure than the rest of the pipe.

To quiet low frequencies, a muffler must have a section with a sizable volume. Overlapping inlet and outlet tubes of this low-frequency section makes for effective design. If these tubes are $4\frac{1}{2}$ in. in diameter or greater to minimize back pressure, muffler outside diameter must be 12 to 14 in. It must be about 3 ft long for proper proportions and adequate volume. If the muffler is oval shape, length must be increased.

The muffler should have one or more high-frequency sections in addition to the low-frequency section, especially for diesel engines. These require some sort of central tube with surrounding chambers of appropriate design. (See Fig. 3.) This section needs a 12 to 14-in. OD about $2\frac{1}{2}$ ft long, with the $4\frac{1}{2}$ to 5-in. tube. Thus a single muffler must be 12 to 14 in. in diameter and 5 to 6 ft long.

Mere size does not guarantee either good quieting or low back pressure. Results obtained depend on engine exhaust characteristics, exhaust and tail pipe dimensions, muffler location in the exhaust system, and internal muffler design.

The 5-cu ft muffler shouldn't be hard to find space for. It only requires 0.1 of 1% of the 5000-cu ft total vehicle volume. There is usually ample space on the cab roof, without affecting in the least the cargo cab, engine space, or road clearance. Most diesel-powered trucks have vertical exhaust pipes. It would be a simple job to connect these to a horizontally mounted 12 or 14-in. by 70 or 80-in. muffler, placed transversely on the cab roof, as shown in Fig. 4.

At most, the chief problem would be a stronger roof. Of course, people are not accustomed to seeing a muffler mounted on the cab roof, or even any truck muffler of practical size. But they have managed to adjust many automotive innovations. I suspect that visual as well as aural evidence of adequate mufflers on high-powered trucks would go far to reduce public indignation.

Muffler life also enters the truck muffler problem. Longevity depends largely on using materials suitable to operating temperatures. Operators burning considerable fuel in the exhaust system will economize with mufflers made of materials that can resist the resulting high temperatures. Even at lower operating temperatures, more permanent materials may prove economical, although less costly materials might be used.

Muffler replacements are costly. It seems that a few dollars spent on first cost of the muffler might well prove considerably more economical on a 250,000-mile basis.

Some maintain the driver can solve the problem by careful operation in critical locations. Obviously the vehicle will make less noise if operated at fractional power. But it's wasteful to operate a 300-hp engine at 50 hp just to reduce noise. It's more reliable and economical to spend a few more dollars on adequate muffling so that the engine can be used as intended.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Explains Axle Load Effect on Highways

Based on paper by

HERBERT S. FAIRBANK

Bureau of Public Roads

(This paper, and discussion of it, will be printed in full in SAE Quarterly Transactions.)

THIS paper discusses the reasons for the 18,000-lb axle load limit now prescribed by law in 34 states. It reviews the road tests which developed facts upon which the present limit is based. And it outlines tests now being carried on which are expected to yield further factual material. The paper then weighs higher road costs against possible savings in vehicle operating costs, assuming a permissible increase in axle loads.

(Paper "Why 18,000 Pounds? Axle Load Effect on Highway Design and Operation," was presented at SAE National Transportation Meeting, New York, Oct. 16, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Look! When Women Have Their Say

Based on paper by

L. O. STOCKFORD

and

K. R. KUNZE

Lockheed Aircraft Corp.

WHEN 365 women employees of Lockheed were asked how they liked the company as compared with other organizations for which they had worked, 51% had a favorable attitude, 20% were neutral, and 29% had an unfavorable attitude.

Married women 18 or 19 years old had the least favorable attitude, married women from 20 to 29 the most favorable, but after 30 the favorable attitude diminished with each older group. Single women under 40 were about neutral, but with advancing age attitude becomes increasingly unfavorable. This was pretty much the case with the widowed and divorced.

When these women were asked what they liked best about working conditions, 30% made specific comment. Women with a mean age of 38 reacted to the equipment, while those with a mean age of 24 reacted more to associates. Those who wholly rejected working conditions were mainly older women.

When asked what they liked least about working conditions, 52% spoke out. Air conditioning came in for most criticism while noise and confusion came next. Women with a mean age of 28 most frequently mentioned temperature. In a room of a given temperature the kind of work performed influenced the individual's appraisal of the hot or cold "value." When women with a mean age of 31 worked in the same room on fabrication and assembly jobs, the mean age of those who find it too hot is 25, those who find it too cold is 40. The explanation may be that younger women are more active and expend more energy than the older women.

Noise and confusion don't faze the under-20-year-olds one bit, but they bother 30% of the over-50 group more than anything else. The under-20 group made no complaint of sanitation either, but each successively older group had more complainers until 30% of the over-50 group gave it as the least favorable aspect of working conditions.

Querying employees on supervision and supervisors make it apparent that the competence of the supervisor as an administrator of his group is the most important single factor for modifying or conditioning employee attitude toward the company. Good personal relations between supervisor and subordinate does not in itself result in any significant increase in morale, nor do unfavorable personal relations result in any significant loss in morale. In fact, among women employees who believe the supervisor to be a good administrator and in addition believe him to be unpleasant personally, the level of attitude toward the company is higher than it is for those who like best their personal relations with the supervisor and in addition have no complaint to make about him.

The employee believes the supervisor to be a good administrator when he interprets and administers company policy in a way that conforms with the subordinate's impressions or understanding of the spirit and letter of company policies. It could well follow that a supervisor, though failing miserably in the opinion of management, would be regarded as an excellent administrator by his subordinates as long as what he did conformed with what they believed should be done. Also, a supervisor could be discharging his responsibilities on a most equitable basis, yet morale of subordinates could be low if his action did not conform with their impressions.

The solution to this problem lies in supervisor training. He must be taught spirit and intent as well as the letter of all policies pertaining to company-employee relations. In addition, he must be made at least familiar with, or aware of, techniques and practices established to effect these policies. He must so inform subordinates about these policies and practices that there will be no basic difference between his interpretation and their impressions.

(Paper "Factory Personnel Problems," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Measurement Makes Designing a Science

Based on paper by

WILLIAM T. BEAN, JR.

Consulting Engineer

THANKS to new tools of measurement, structural design and its development has become a science in the last decade. The engineer can now build on facts instead of assumptions.

The analytical approach to design has been oversold. Solutions reached through this approach are trial solutions, not THE solutions. An engineer who thinks he can make enough assumptions to calculate the facts is lacking in experience, for in spite of thousands of tables on the strength of materials, actual strength as found in the manufactured product will vary between 30 and 300% from the accepted handbook value. The experienced designer finds that he is confronted with such variables as: size effect, surface finish, residual stress, state of stress, surface composition, homogeneity, temperature, and vendor's know-how.

Mathematics in the hands of an expert is not powerful enough to disclose the true stress distribution inherent in most engineering structures. Calculated stresses in a rather simple machine element like a connecting rod will differ from the actual stresses by some 30 to 300%. Dynamic load multipliers due to impact and resonant vibration are easily measured, but difficult to predict. Actual service loads are found to vary from the calculated load by a factor ranging from 10 to 800%.

This is not to say that because of prevailing errors the analytical approach is outmoded by measurements. Rather that since the design must be built before the measurements are taken, it will be a better initial design if based on engineering calculations instead of engineering guesses.

Design development through measurement is a fact-finding program which begins when sample components are available for testing. Since most

machine elements are subjected to cyclical loads, their failures are predominantly by fatigue, therefore, fatigue machines are used to obtain factual data. They should be used to measure the strength of a material, but not to determine load-carrying ability of a given design. Once the allowable stress that the material will sustain has been established, a stress analysis of the new design is all that is required to see if the allowable stresses are compatible with the operating stresses. Stresscoat is the most practical tool for design analysis, its accuracy ranging from five to 25% depending upon the skill of the operator. Stresscoat permits visual observation of stress distribution and indicates location and orientation of wire strain gages which measure strain with an accuracy of 2%. Then wire strain gages can be used to measure service loads.

By the use of transducers, employing wire strain gages, measurements of force, torque, pressure, displacement, and acceleration are readily obtained. And bonded wire gages sensitive to temperature instead of strain are also available. Thus, with new tools, an entirely new system of measurement is at hand which will indicate and record all basic engineering phenomena such as force, torque, strain, vibration, temperature, pressure, thickness, and surface finish. These new instruments are of tremendous significance to production men, too, because machine tools can now be controlled automatically to a greater degree of accuracy than has been possible heretofore. Scrap is not a problem of inspection; it is eliminated at its source.

(Paper "Design by Measurement," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 12, 1950. It is available in full multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Meeting Turboprop Installation Problems

Based on paper by

F. HERBERT SHARP

Consolidated Vultee Aircraft Corp.

TURBOPROP installation problems have their beginning in the bid proposal specifications given out by the Bureau of Aeronautics or the Air Force. The designer is given some latitude in the choice of turbines and propellers and all factors must be considered if the resultant airplane is to meet performance specifications, with a little extra thrown in. Versatility in accomplishment is important because few military planes ever live out their service life in the original configuration.

The designer must decide whether to use two 10,000-hp turbines or 10 turbines of 2000 hp. He must ask himself what he wants—high power performance at all times, or high take-off power and economical cruising speed. Then he must decide upon the most desirable nacelle configuration. (See Fig. 1.)

Turbine and propeller availability should permit test stand operation duplicating the airplane nacelle while the airplane is being built, otherwise there must be sufficient ground run time to permit working out the nacelle bugs before flight. If the desired turbine is still on the drawing board, a thoroughly tested interim engine should be used for early evaluation of the airframe.

The service reputation of a turbine is important. Its reliability, specific fuel consumption, life between overhauls, and resistance to battle damage, must all be considered. (See Fig. 2.) And lastly comes the problem of accessories.

The paper also tells briefly how installation problems were solved or exposed for future solution in the building of the Convair XP5-1, Navy seaplane. (Paper "Turboprop Installation Problems," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

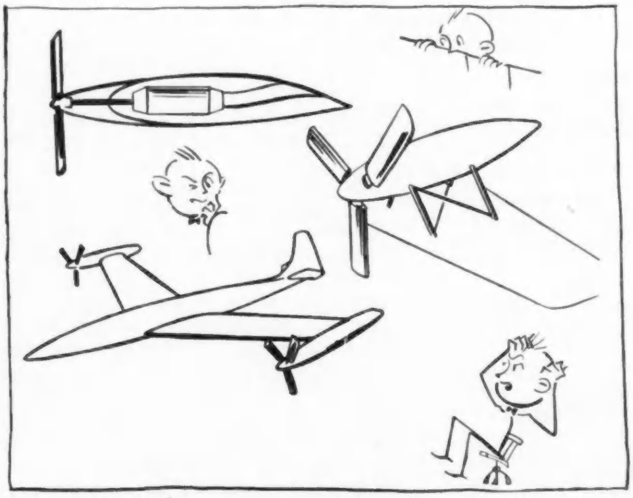


Fig. 1—Designer's choice in nacelle configuration: a nice smooth submerged installation for the man who doesn't like to count drag counts; a pedistal mount for the engineering department whose wing and powerplant groups aren't speaking to each other; a wing tip installation on a superthin swept wing creation.

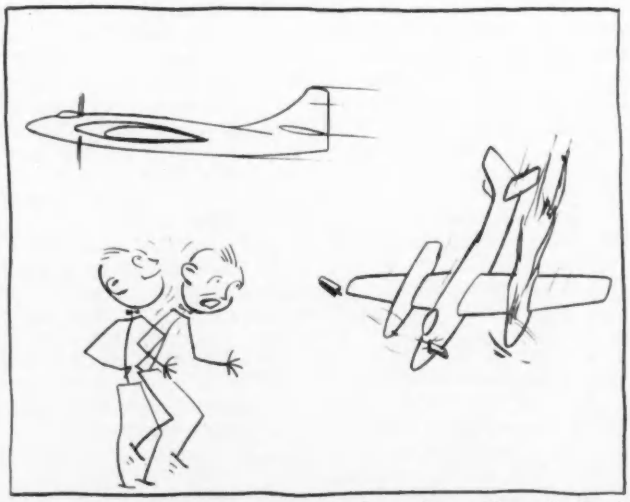


Fig. 2—How much battle damage will the turbine withstand? Service reputation is an item to consider when selecting the powerplant for a military airplane.

Mechanical Defects Lift Accident Rate

Based on paper by

H. H. ALLEN

and

LOUIS REZNECK

Bureau of Motor Carriers

MOTOR carrier accidents caused by mechanical defects have increased steadily since 1944, fatalities and injuries have declined, while property damage has risen.

The full reason for the downward trend of fatalities and injuries is unknown, but there are two influencing factors. First, there is better reporting of non-casualty accidents, which alters percentages. Second, passenger carriers have done better than property carriers in accident reduction. And passenger carrier accidents are more likely to result in multiple injuries. The property damage increase, which is out of proportion to the accident increase, is due mainly to the rise in national price structure.

The number of brake accidents is increasing both numerically and as a percent of all mechanical defect accidents. Here again property carriers make a poorer showing than passenger carriers. Studies show that certain type defects are unlikely to occur on buses. For example: Only one out of 32 lighting system failure accidents involved buses, whereas for engine failures, one out of three occurred on buses. Any careful examination of the wiring system on the average bus as compared with that on the average tractor-semitrailer reveals that this ratio exists because bus installations are almost all factory installed, whereas property carriers use makeshift and field installations to a large degree, especially in the hook-up between units of a combination vehicle. In some cases maintenance is poor because original design was bad. Over 90% of service brake accidents of known cause on tractor-semitrailer combinations can be traced to poor maintenance.

The mechanical defect ratio for buses in 1949 was one accident for every 8,000,000 miles, whereas for property carriers there was one accident for every 3,000,000 miles. Since there are few basic differences in the original construction of such vehicles insofar as likelihood of failure is concerned, the main reason for rate difference must be because of better maintenance by one class of carrier as contrasted with the other.

A "stopped" accident is five times more likely to result in a fatality, about 50% more likely to result in an injury, but less likely to result in property damage, than a "moving" one. Fortunately the proportion of "stopped" accidents has declined slightly. This is due to better training of drivers in the placing of protective equipment and better maintenance of such equipment.

Leased vehicles have a mechanical defect accident rate about 34% higher than that of vehicles owned by the motor carrier. This indicates once again a correlation between the degree of maintenance and the frequency of mechanical defect accidents. (Paper "Relationship Between Maintenance and Motor Carrier Accidents," was presented at SAE National Transportation Meeting, New York, Oct. 16, 1950. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Hydraulic Power Lightens Farm Work

Based on paper by

HENRY A. FERGUSON

International Harvester Co.

(This paper will be printed in full in SAE Quarterly Transactions.)

BACK-BREAKING labor on the farm has been well-nigh eliminated by hydraulic power for the handling of implements. Sensitive control, requiring little or no maintenance, is now applied to an infinite variety of machines, such as: plows, middlebusters, listers, planters, cultivators and mowers, to name a few.

Original remote control systems used mechanical cam action against the ground to lift the tool from the soil. They were unsatisfactory in performance where ground was soft or wet and hydraulic systems replaced them. Today, four general types of hydraulic control are in use, despite the need for special control action for each implement. These types are: nudging, modified nudging, automatic draft, and follow-up.

All systems must include at least a pump, reservoir, control valve, safety valve and operating power cylinder, but there are only three basic oil circuits in common use.

This paper presents a detailed description of hydraulic control system operation and illustrates each system. (Paper "Hydraulic Control Systems for Farm Tractor Implements," was presented at SAE National Tractor Meeting, Milwaukee, Sept. 12, 1950. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Crystal Gazing At Air Transport

Based on paper by

EDWARD C. WELLS

Boeing Airplane Co.

WITHIN the next five years we can confidently expect to build and use practical transports capable of flying at mach numbers approaching 1.0 and at ranges permitting non-stop transatlantic operation with reasonable payloads. Supersonic commercial flight does not appear to be feasible from the economic standpoint, but technically, certainly, it will be available to us within 10 years or less.

No one type of powerplant offers a complete answer to all desires for economy, simplicity, performance, reliability and safety. Turbine power should and will replace reciprocating power, but we can speak with less assurance about turboprops versus turbojets because of intangible influencing factors. There are jobs for both types to do and the only big mistake we might make would be to fail to develop both types continuously and intensively. And we should not commit ourselves to increasing complications in an effort to improve fuel economy.

In equipment development we are following a trend of ever increasing complication. This trend must be reversed or checked if we are to have other than a dim technical future in this field.

That doesn't mean that automatic controls never should be used. Some functions can best be performed by such controls. But if a manual control performs a necessary function satisfactorily, let us not be led astray by some minor advantage offered by automatic controls.

If the function itself is superfluous —as some are—do not put in a control, least of all a complicated automatic one just to prove we can do it.

No one aircraft nor any one operator provides adequately for utility and comfort. Ahead of us are two development steps, first a better analysis of needs and a better job of design to suit those needs, and next a really effective effort towards standardization on those items suited to standardization. Many items should be, and are, strictly interchangeable and identical. Many more could and should be. Still others should be more nearly identical from a functional standpoint.

The future should lead to consideration of the maintenance factor as one of the primary ones in formulating the basic design. In many cases if maintenance needs could be established early in the design program, then most basic features leading to ease of maintenance could be incorporated with no increase in weight or drag.

New powerplants, less complication

Continued on Page 96

About

General Motors Executive Changes

Goad

Gordon

Chayne

L. C. GOAD has been named by General Motors as executive vice-president in charge of the Corporation's car and truck group, body and assembly divisions, and the accessory group. He has also been named a member of GM's board of directors.

J. F. GORDON succeeds Goad as group executive in charge of body and assembly plants.

C. A. CHAYNE, who has been Buick's chief engineer for many years, becomes vice-president in charge of the GM engineering staff, succeeding Gordon. Two other SAE members, in addition to Goad, have been named members of the GM board of directors. They are: **CARL H. KINDL**, vice-president in charge of the overseas and Canadian group, and **CYRUS R. OSBORN**, vice-president in charge of the engine group.

(Other General Motors executive changes will be announced in the February Journal.)

R. K. WHITTLESEY is now field representative with Westinghouse Air Brake Co. in Seattle, Wash.

RALPH SIEMERS, who, prior to this, was an experimental project engineer with Kaiser-Frazer Corp., Willow Run, Mich., is now project engineer with the Cadillac Cleveland Tank Plant, Cleveland. His new position entails setting up the engineering laboratory and test facilities for the tank plant.

JEROME RUBLER, formerly a mechanical engineer with D. Sparagna Equipment Co., Long Island City, N. Y., is now equipment engineer and maintenance officer with the U. S. Army at Camp Rucker, Ala., holding the rank of lieutenant.

J. O. ALMEN, Research Laboratories Division, GMC, authored the extensive article, "Fatigue Weakness of Surfaces," in the November, 1950 issue of Product Engineering. Front cover of the magazine shows Almen at work in his laboratory. He is the first chairman of the Shot Peening Division, SAE Iron & Steel Technical Committee.

Rugge

RAY A. RUGGE has been elected president and general manager of The Kilgore Mfg. Co., Westerville, Ohio. Prior to joining Kilgore, Rugge was chief engineer of Lear, Inc., and earlier was head of the electrical design and development departments of the Airplane Division of Curtiss-Wright Corp., Columbus, Ohio.

R. H. OSBRINK is now vice-president of Saunders Castings, Inc., Wichita, Kansas. The company provides an aluminum and magnesium casting service for the aircraft industry in the middle west; specializing in precision, heat treated aircraft castings.

Bossart

OTTO A. BOSSART has been appointed sales and engineering representative for the Contract Products Division of the Young Radiator Co., Racine, Wis. Bossart is a graduate of the University of Wisconsin with a Bachelor of Science degree in Mechanical Engineering.

PAUL H. DAILY is district manager with Cummins Sales & Service, Inc., Fort Worth, Texas. Prior to this, he was service and store manager with the Superior Engine Division of the National Supply Co., Springfield, Ohio. His new position entails the supervision of sales and service of Cummins Diesel Engines in the lower Louisiana and Mississippi area.

Hayden

MERRILL A. HAYDEN, formerly assistant sales manager of the Industrial Division, Vickers, Inc., Detroit, has been transferred to the Waterbury Tool Division of Vickers where he is general sales manager.

ROBERT M. PALMER, formerly truck sales manager with Willys-Overland Motors, Inc., Toledo, Ohio, is now assistant chief engineer with the Dart Truck Co., Kansas City, Mo.

MANSELL H. MOORE, formerly general manager of National Automotive Parts Co. Ltd., Toronto, Ont., is now president of Motive Parts & Equipment Ltd., Toronto.

ROBERT S. RILEY, who, prior to this, was superintendent of the Precision Chuck & Collet Division of Jacobs Mfg. Co., West Hartford, Conn., is now an experimental engineer with Kaman Aircraft Corp., Windsor Locks, Conn. He is in charge of all ground testing of helicopters and their component parts. In 1948, he was a member of the SAE Southern New England Section Reception Committee.

Members

EARL P. COOPER, famous racing car driver from 1911 to 1926, recently resigned after twenty years service as chief automotive engineer with the Union Oil Co. of Calif. He has taken an active part in SAE work for the past fifteen years. Too active for retirement, Cooper is now associated with the Grand Central Garage Co., Los Angeles, Calif., national distributors of the Earl Cooper Wheel Balancing Machine.

JOHN W. PENNINGTON has left his position as staff engineer in Caterpillar Tractor Co.'s research department to become chief engineer of the piston ring department of Koppers Co., Baltimore. He had been serving as Central Illinois Section chairman until his December 1 change in position.


Willis

C. E. WILLIS has been appointed chief engineer with Lear, Inc., Grand Rapids, Mich. Willis has been associated with Lear since 1947, first as manager of their Eastern office and later as assistant sales manager of the Electro -Mechanical Division in charge of Lear West Coast sales and field engineering activities. In his new capacity Willis will be applying at the design level the benefits of his extensive experience in the successful solution of aircraft accessory equipment problems.

T. E. MARTIN, previously assistant chief engineer with The Oliver Corp., Charles City, Iowa, has been promoted to chief engineer with that same company in Springfield, Ohio. His new position entails the direction of product design, and development and experiment testing.


Boyd

WINNETT BOYD has resigned as assistant chief engineer and chief designer of A. V. Roe Canada Gas Turbine Division. It is Boyd's intention to establish his own consulting engineering practice in Toronto, and it is anticipated that he will continue his association with the expanding gas turbine industry, in which he has been an outstanding figure since the commencement of this work in Canada.

S. B. WANNER, of the Chicago sales office of Purolator Products, Inc., Rahway, N. J., has been appointed assistant sales manager for equipment sales. Wanner started with Purolator in 1934 as an inspector, and then went to engineering as a draftsman. He became a sales engineer in 1935, and has been with the Chicago sales office since 1948.

C. S. HANSEN, formerly of the Phillips Petroleum Co., sales department, recently joined the Pure Oil Co., Chicago. Hansen heads the Technical Sales Group of Pure Oil in that city.

J. H. W. CONKLIN resigned as sales manager for the Clark Equipment Co.'s Industrial Truck Division, to associate himself with another enterprise.

RICHARD WHEELER, JR., is now chief engineer with the Mackenzie Muffler Co., Youngstown, Ohio. Prior to this, he was project engineer with Packard Motor Co., Detroit.

WILLIAM B. LIVINGSTON, previously president of Metropolitan Motor Coaches Inc., Highland Park, Mich., is now sales manager of the William J. Ulrich Co. Detroit.

WARREN B. HASTINGS, a member of the Governing Board and a past chairman of the SAE Canadian Section, has been named general manager and secretary-treasurer of the Ontario Motor League. Hastings is the acting secretary-treasurer of the Canadian Automobile Association, federation of


Hastings

the motor leagues of all the provinces. He is also a member of the Advisory Committee on Highway Research and of three of the National Canadian Standards Committees. A pioneer in automotive journalism, he wrote the first regular automotive column to be published in a newspaper in Canada. For 36 years he has been a senior executive of the O.M.L. and editor and manager of the Canadian Motorist, official publication of the Canadian Automobile Association.

VICTOR MILLMAN, formerly test engineer with General Electric Corp., Schenectady, N. Y., is now an engineer and draftsman with Sverdrup and Parcel, Consulting Engineers, St. Louis, Mo.

REAGAN C. STUNKEL, who, prior to this, was president of Aviation Maintenance Corp., Van Nuys, Calif., is now vice-president of Hydro-Aire, Inc., Burbank, Calif.

FRANK A. VOSBURGH, JR., is now employed by the Hudson Lamp Co., Arlington, N. J. as manager of the Carlton Lamp Division. He was previously president of the Carlton Lamp Corp., Newark, N. J.


Hecker

CARL L. HECKER, vice-president in charge of manufacturing of The Oliver Corp., Chicago, was elected to the board of directors of the Chicago farm and industrial equipment manufacturer at the regular Director's Meeting. Hecker has been with Oliver since 1946, when he joined the company as general manager of its South Bend plants. He was born in Columbus, Ohio in 1902 and graduated from Ohio State University.

Turn to Page 79

Students Enter Industry

ROBERT A. MORRISON (California Polytechnic Institute '50) to U. S. Electrical Motors, Inc., Los Angeles, Calif.

CLARENCE KELLER, JR., (Tri-State College '50) to Bendix Aviation Corp., South Bend, Ind.

HENRY M. GRANDIZIO (College of the City of New York '50) to Picatinny Arsenal, Dover, N. J.

LEROY E. GARWOOD (Northrop Aeronautical Institute '50) to Douglas Aircraft Co., El SeGundo, Calif.

KENNETH R. FITCH (Stevens Institute of Technology '50) to Grumman Aircraft Engineering Corp., Bethpage, N. Y.

BERNARD I. FISHER (Cooper Union School of Engineering '50) to Wright Aeronautical Corp., Wood-Ridge, N. J.

DONALD EUGENE FERRO (Purdue University '50) to Bendix Aviation Corp., South Bend., Ind.

FRANK L. JARRETT (University of California '50) to Food Machinery and Chemical Corp., San Jose, Calif.

ROBERT E. JONES (Bradley University '50) to Rome Cable Corp., Rome, N. Y.

RUDOLPH J. DESANTO (Wayne University '50) to Mueller Brass Co., Port Huron, Mich.

DAVID L. DEIBEL (Case Institute of Technology '50) to The Cleveland Twist Drill Co., Cleveland.

MARTIN L. TOWNER (University of Aeronautics '50) to Piasecki Helicopter Corp., Morton, Pa.

PERRY SWARTZ (Wayne University '50) to Fleetwood Division of Fisher Body Division, GMC, Detroit.

CLAYTON E. ANDERSON (Michigan State College '50) to Fisher Body Division, GMC, Detroit.

DONALD E. BALSER (Purdue University '49) to The Pierce Governor Co., Inc., Anderson, Ind.

CHARLES RAY GOODWIN (Northrop Aeronautical Institute '50) to Douglas Aircraft Co., Long Beach, Calif.

WARREN R. SALZMAN (Purdue University '50) to Babcock & Wilcox Co., Darperton, Ohio.

GLEN A. WEINERT (University of Michigan '50) to Ohio University, Athens, Ohio.

PETER L. CROWN (Brooklyn Polytechnic Institute '50) to U. S. Government Armed Service, Brooklyn, N. Y.

PETER W. NAYLOR (University of Maryland '50) to Army Chemical Corp., Edgewood, Md.

JAMES F. GREEN (University of Notre Dame '50) to American Steel Foundries, Cincinnati, Ohio.

RALPH C. BOLZ (Chrysler Institute of Engineering '50) to Chrysler Engineering, Detroit, Mich.

WILLIAM A. JUDE (University of Colorado '50) to Denver Fire Clay Co., Denver, Colo.

W. T. S. PEARCE (University of British Columbia '50) to Shawnijan Lake School, B.C.

GALE W. PORTER (Wayne University '50) to Fuelcharger Corp., Mich.

DAVID C. PORTZ (Columbia University '50) to General Exchange Insurance Co., N. Y.

RUSSELL T. POSTHAUER (Academy of Aeronautics '50) to Durham Aircraft Service Inc., Mineola, N. Y.

KENNETH J. PRCHAL (Aeronautical University '50) to L. V. Whitney Distributor Corp., Chicago, Ill.

EVERETT A. PRINGLE (Northwestern University '50) to Revere Copper & Brass, Inc., Ill.

ROBERT QUINN (Indiana Technical College '50) to Brouwer Tire & Battery, Ind.

THOMAS J. QUINTANA (California Polytechnic College '50) to Douglas Aircraft Co., Long Beach, Calif.

JAMES T. RANKIN (California State Polytechnic College '50) to Clayton Mfg. Co., El Monte, Calif.

ROBERT C. BERFORD (Chrysler Institute '50) to Chrysler Corp., Detroit, Mich.

GEORGE A. CUNNINGHAM (Aeronautical University '50) to McDonnell Aircraft Corp., St. Louis, Mo.

JACK KESTER WILLIS (California Institute of Technology '50) to Douglas Aircraft Co., Inc., Santa Monica, Calif.

H. FRANCIS NADEAU (University of Massachusetts '50) to Selig Mfg. Co., Inc., Mass.

ROBERT ARTHUR NELSON (California State Polytechnic College '50) to Oliver United Filters, Oakland, Calif.

LEO G. NICHOLAS (University of Massachusetts '50) to Holger Hansen Mfg. Co., Lynn, Mass.

ANDREW K. NIELSEN, JR., (University of California '50) to Condick Co., Berkeley, Calif.

C. G. NORRIS (University of British Columbia '50) to Interior Farm Equipment Co., British Columbia.

WILLIAM P. OTT (The Pennsylvania State College '50) to General Electric Co., Schenectady, N. Y.

LEO S. PARRY (Wayne University '50) to Harry Ferguson, Inc., Detroit, Mich.

WILLIAM H. PECK (Purdue University '50) to The Babcock & Wilcox Co., Cleveland, Ohio.

EDWARD E. PETERS III (Yale University '50) to Peters Packing Co., McKeesport, Pa.

EDWARD PINSLEY (Massachusetts Institute of Technology '50) to United Aircraft Corp., East Hartford, Conn.

JOHN W. MICHAELSEN (Wayne University '50) to Snyder Tool and Engineering Co., Detroit, Mich.

RICHARD H. MOORE (Purdue University '50) to Naval Ordnance Laboratory, Silver Spring, Md.

ROY W. MORLING (University of Illinois '50) to The Oliver Corp., Charles City, Iowa.

FRANCIS V. MUSHIAL (Purdue University '50) to Brush Development Corp., Cleveland, Ohio.

ROBERT J. MUZZY (Massachusetts Institute of Technology '50) to A. O. Smith Corp., Milwaukee, Wis.

WILLIAM NOVICK (College of the City of New York '50) to N. Y. State

Continued on Page 90

Continued from Page 77

EVERETT VICTOR ALLEN is now a design engineer with Hughes Aircraft Co., Culver City, Calif. Prior to this, he held a similar position with Western Gear Works, Lynwood, Calif.

LEE OLDFIELD has resigned his connection as president and director of Laboratory Equipment Corp., Mooresville, Ind., having sold his interest in the concern to C. Stanley Sundling. He will continue as an engineering consultant with the organization.

JAMES KNOWLES, who, prior to this, was resident engineer with Ford Motor Co. at the Cincinnati plant, is now chief engineer with the Aircraft Engine Division of Ford in Dearborn, Mich. He was on the SAE Detroit Section Membership Committee in 1946.

ANDERSON ASHBURN, associate editor of American Machinist, is the author of the recently published book, "Automotive Trouble Shooting and Maintenance." Written for vocational schools as well as car and truck drivers, this book tells how to shoot troubles in the vehicle electrical system, fuel system, cooling system, engine, power train, and chassis. Procedures for finding the source of trouble are given. The author considers basic principles rather than particular car models or makes. The book, published by the McGraw-Hill Book Co., contains 305 pp. and its price is $4.50.

REINO J. NIEMELA, formerly project engineer with Jack & Heintz Precision Industries, Inc., Cleveland, is now employed by Aero Engineering Inc., Mineola, N. Y., in the capacity of field engineer. In his new position he provides sales and engineering services for twelve aircraft products companies.

THEODORE M. FAHNESTOCK, formerly manager of the Service Engineering Division of the Caterpillar Tractor Co., Peoria, Ill., is now chief of the Maintenance Division with the U. S. Army, Fort Leonard Wood, Mo. He had been serving as vice-chairman of SAE Central Illinois Section (1950-51).

PROF. JOHN J. UICKER, director of the department of mechanical engineering at the University of Detroit, has been made a member of the Committee on (professional) Registration of the American Society of Mechanical Engineers. Professor Uicker, who assumed the directorship of his department in 1943, formerly taught at the University of New Hampshire and The Pennsylvania State College. He is an engineering consultant and is director of refresher course for State Board Exams for the Engineering Society of Detroit. He also teaches engineering subjects to engineers for the Engineering Service Co. of America, Inc.

S. VIJAYARAGAVAN, formerly with M/s T. V. Sundram Iyengar & Sons Ltd., Mathurai, South India, is now assistant works manager with Sundaram Motors Ltd., Madras, South India.

R. P. DINSMORE, Goodyear's vice-president of research and development, told American Chemical Society's Pittsburgh group in November that: The United States, in event of war, will need about 1,000,000 tons of rubber a year—and, at the very least, 25% of it must be in natural rubber. . . . And, whatever the stockpile may be, it will require one or two years' supply to provide enough for a war of four or five years' duration.

E. R. DONNER, previously senior fuel and lubricants engineer with Standard Oil Co. of California, Salt Lake City, Utah, is now supervising fuel and lubricants engineer with that same company in Long Beach, Calif.

ROBERT WRIGHT NORTHUP is now research assistant in the department of aeronautical engineering, Princeton University, Princeton, N. J. Prior to this, he was a project engineer with the Allison Division, GMC, Indianapolis, Ind.

HECTOR ALEXANDER has been elected vice-president of the Frank Ambrose Aviation Co. Alexander's aviation background as a pilot and aircraft engine specialist dates back to World War I. His career began with the Packard Motor Co. in 1915 and since that time, he has become prominently identified throughout the automotive, marine and aviation industries.

RALPH N. DUBOIS recently was made dean of the School of Aircraft Engineering at the Institute of Technical Aeronautics of Brazil, with which he has been associated for a number of years. The course in this government-sponsored school requires six years to a bachelor's degree and applicants are chosen in competitive examinations such as those given for West Point in the United States. DuBois is currently engaged in completing and installing equipment in three new laboratories for his School of Aircraft Engineering. He writes:

"The entire project was designed by Oscar Wiemeyer, famous Brazilian architect. Life there is going to be similar to life on an Army post. All of us on the faculty will live in faculty houses on the campus and buy our staples at a 'post exchange'. The campus is so large that we have scheduled bus service between residences, laboratories, and the main school buildings. The airport has 12,000-ft runways along two sides of the campus."

Continued on Page 90

OBITUARIES

WALTER H. BEECH

Walter H. Beech, founder and president of the Beech Aircraft Corp., and internationally famous aviator and manufacturer, died of a heart attack on November 29. He was 59 years old.

The aeronautical experiences of Walter H. Beech extended over more than a quarter century. Born and raised on a farm near Pulaski, Tenn., Beech enlisted in the Army Air Corps when the United States entered World War I. For three years he served as a pilot, flight instructor, and engineer, and upon his return to civilian life became a barnstorming pilot. Having been employed in various capacities, he became eager to put his own ideas into practice and organized his own company, Travel Air. In 1932, he founded and became president of the Beech Aircraft Co. With only rare absences from his desk for necessary trips throughout the world, he served as president, director, and finally chairman of the board of that company.

From the time Beech turned from military to civilian aviation, he entered numerous races and his personal achievements in this field made up one of the most extensive lists compiled in aircraft racing. The record that did the most to win him recognition was his winning of first place in the first Ford Reliability Tour in 1925.

Beech was a member of the Advisory Board of Institute of the Aeronautical Sciences; Navy Industrial Association; Air Power League; National Aeronautics Association; Veteran Air Pilots; Sportsman Pilot; Wings Club; Quiet Birdmen; president of Personal Aircraft Council of Aircraft Industries Association and member of Board of Governors of AIA; also was member of Aircraft Manufacturers Council, Eastern Region Executive Committee of AIA. He had been a member of SAE since 1932 and had made many contributions especially to the Wichita Section.

FRANK J. ROEHRENBECK, JR.

Ensign Frank J. Roehrenbeck, Jr., naval aviator, was killed July 18 in a plane crash landing on the aircraft carrier USS Midway. Roehrenbeck, who was 24 years old, recently completed the jet training course at the Naval Auxiliary Air Station, Milton, Fla. He won his Navy wings and title of navy aviator six months ago at the Naval Advanced Training Command, Corpus Christi, Texas, and was assigned to the USS Midway. He was born in Jersey City, and graduated from Yale University in 1947. The following year he entered the U. S. Navy under the Direct Procurement Program and was commissioned to active flight training in August, 1948.

TECHNICAL COMMITTEE *Progress*

Propose Preferred Number System For Metal Strip and Sheet Gage

By* J. GURSKI, Ford Motor Co.
and W. WIERS, Fisher Body Division, GMC

SAE Representatives on ASA Sectional Committee B-32

FOR years, industry has been laboring under the handicap of numerous gage systems which differed from each other. Originally, they served a useful function and, in the restricted areas in which they were used, acted as a preferred series of thicknesses without confusion. With the development of transportation and the mass introduction of precision measurement, the gage systems have not only outlived their usefulness, but have become a source of confusion.

Table 1—The 40 Series of Preferred Numbers Proposed for Thicknesses of Metal Sheet and Strip

0.010*	0.034	0.100*
0.011*	0.036*	0.106
0.012*	0.038	0.112*
0.013	0.040*	0.118
0.014*	0.042	0.125*
0.015	0.045*	0.132
0.016*	0.048	0.140*
0.017	0.050*	0.150
0.018*	0.053	0.160*
0.019	0.056*	0.170
0.020*	0.060	0.180*
0.021	0.063*	0.190
0.022*	0.067	0.200*
0.024	0.071*	0.212
0.025*	0.075	0.224*
0.026	0.080*	0.236
0.028*	0.085	0.250*
0.030	0.090*	
0.032*	0.095	

* Indicates 20 series of preferred numbers.

Accordingly, it is proposed to replace the gage systems with a decimal series of preferred numbers for sheet and strip steels, brasses, copper, and all other flat uncoated metals under 0.250 in. in thickness.

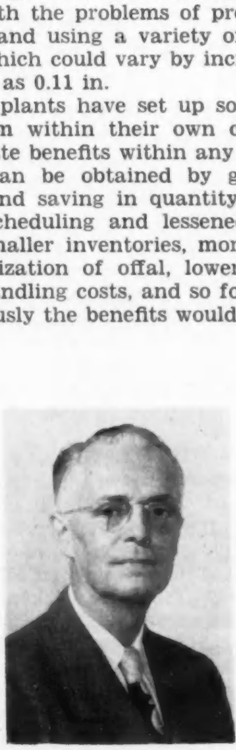
The establishment of "preferred thicknesses" has nothing to do with tolerances. Tolerances established by the American Iron and Steel Institute, American Society for Testing Materials, and the Copper and Brass Research Association, or individual companies will be used. A preferred thickness is merely a suggested thickness to be used when it is not mandatory to use some other thickness. Preferred thicknesses are guides for the designer.

While the designer is not customarily concerned with the procurement, scheduling, or stocking of steel or other metals, he ultimately becomes the key figure when these functions have to be performed. If he approaches the problem with the idea of coordinating with Manufacturing, he is practically forced to adopt some system of preferred thicknesses. If he does not, Purchasing and Manufacturing may be faced with the problems of procuring, storing, and using a variety of thicknesses which could vary by increments as small as 0.11 in.

Many plants have set up some sort of system within their own confines. Immediate benefits within any organization can be obtained by grouping orders and saving in quantity extras, easier scheduling and lessened paper work, smaller inventories, more effective utilization of offal, lowered material handling costs, and so forth.

Obviously the benefits would become

* A progress report on the latest development in establishing "Preferred Thicknesses for Uncoated Thin Flat Metals (under 0.250 in.)," made to the Executive Committee, of the SAE Iron & Steel Technical Committee.



L. E. Wells, Electric Storage Battery Co., has been appointed chairman of the Storage Battery Subcommittee, of the SAE Electrical Equipment Committee

uch greater if all plants would adopt ie same system.

Such standardization ultimately aches far back to the source of the w materials and, under normal cir- umstances, results in lowered costs.

ASA Sectional Committee B-32, on he Standardization of Wire and Sheet Metal Gages, has recently been re- ctivated and has expanded the pre- iously recommended series of pre- ferred numbers to give greater cover- age. No thicknesses are to be re- garded as nonstandard and no penalty is to be attached to the use of such thicknesses. Table 1 lists thicknesses as recommended by ASA.

You will note from Table 1 that practically every gage used in the Manufacturer's standard has its deci- mal thickness included.

The problem of adopting such a system always has been difficult because of inertia. The vendor says he is willing to furnish anything the customer wants, but the customer has difficulty in getting together with other customers, so that everyone does things individually.

Statistical data show that the automotive industry uses 45% of all the sheet steel. If the system is adopted by such a large user industry, it would only be a matter of time before practically everyone would realize its benefits. The use could be very easily spread from mild steel to other steels and to nonferrous metals.

It certainly would be fitting for the automotive industry, which has a record of getting things done, to take positive action in this "no man's land" of raw material sizes and reap the saving by standardization.

You'll Be Interested to Know . . . . . .

DETROIT SECTION has added a new activity, engineering materials, to the many facets of automotive engineering it already encompasses. M. F. Garwood, Chrysler Corp., has been appointed to the Section's Governing Board as vice-chairman for engineering materials. A. E. Proctor is assistant vice-chairman for the activity. Other SAE Sections with engineering materials representation on their governing boards are Chicago, Milwaukee, Pittsburgh, and Washington.

JOHN G. FINDEISEN, assistant sales manager for Caterpillar Tractor Co., has taken over the chairmanship of Central Illinois Section. The post was vacated when former chairman John W. Pennington accepted a new position in Baltimore.

Correction

In the article "Revised SAE Oil Grades Score Three-Way Advance," on page 86 of the November, 1950, SAE Journal, the preamble to the newly revised SAE Crankcase Oil Classification was omitted. The Classification, in its entirety, should read as follows:

Crankcase Oil Classification
SAE Recommended Practice

The SAE Viscosity Numbers constitute a classification for crankcase lubricating oils in terms of viscosity only. Other factors of oil character or quality are not considered.

Viscosity numbers without an additional symbol are based on the viscosity at 210 F.

Viscosity numbers with the additional symbol "W" are based on the viscosity at 0 F.

The viscosity of oils included in this classification for use in crankcases shall be not less than 39 sec at 210 F, Saybolt Universal.

In the case of prediluted oils, SAE Viscosity Numbers by which the oils are classified shall be determined by the viscosity of the undiluted oils.

Wherever the SAE Viscosity Numbers are used on prediluted oils, the container labels should show in some suitable manner that the SAE number applies to the undiluted oil.

SAE Viscosity Number	Viscosity Range, Saybolt Universal, Sec at 0 F		at 210 F	
	Min.	Max.	Min.	Max.
5W	—	4,000	—	—
10W	6,000 (Note A)	less than 12,000	—	—
20W	12,000 (Note B)	48,000	—	—
20	—	—	45	less than 58
30	—	—	58	less than 70
40	—	—	70	less than 85
50	—	—	85	110

Note A. Minimum viscosity at 0 F can be waived provided viscosity at 210 F is not below 40 sec, Saybolt Universal.

Note B. Minimum viscosity at 0 F can be waived provided viscosity at 210 F is not below 45 sec, Saybolt Universal.

Approved and Proposed Aero Materials Specs

TWO new SAE Aeronautical Materials Specifications and thirty five revised ones were approved recently by the SAE Technical Board. Thirty two others—three new and twenty nine revised—are being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division.

a. The new ones approved are:

- AMS 5720, Steel, Corrosion and Heat Resistant, 20Cr—9Ni—1.4Mo—1.4W—(Cb + Ta)—Ti
- AMS 5573, Tubing, Seamless, Corrosion and Heat Resistant 17.5Cr—12.5Ni—2.5Mo (SAE 30316)

b. The revised ones approved are:

- AMS 2231A, Tolerances, Carbon Steel Bars
- AMS 2232A, Tolerances, Carbon Steel Sheet and Strip
- AMS 2242A, Tolerances, Corrosion and Heat Resistant Sheet, Strip and Plate
- AMS 2251A, Tolerances, Alloy Steel Bars
- AMS 5362B, Steel Castings, Precision Investment, Corrosion and Heat Resistant, 19Cr—12Ni—(Cb + Ta)
- AMS 5363A, Steel Castings, Sand, Corrosion and Heat Resistant 18Cr—10.5Ni—(Cb + Ta)
- AMS 5512B, Steel Sheet and Strip, Corrosion and Heat Resistant 18Cr—11Ni—(Cb + Ta) (SAE 30347)
- AMS 5571A, Steel Tubing, Seamless, Corrosion and Heat Resistant 18Cr—11Ni—(Cb + Ta) (SAE 30347)
- AMS 5575E, Steel Tubing, Welded, Corrosion and Heat Resistant 18Cr—11Ni—(Cb + Ta) (SAE 30347)
- AMS 5616A, Steel, Corrosion and

Continued on Page 94

CALENDAR

British Columbia—Jan. 15

Hotel Georgia; dinner 6:30 p.m. "Garagemen's Night." Panel of Experts.

Canadian—Jan. 17

Royal York Hotel; dinner 7 p.m. Meeting 8:00 p.m.

Central Illinois—Jan. 22

Hotel Jefferson; Dinner 6:30 p.m. Meeting 7:45 p.m. "Improved Strength Through Modern Design" Dr. Oscar Horger, Ch. Engr., Timken Roller Bearing Co., Railway Division.

Chicago—Jan. 22

LaSalle Hotel; Dinner 6:45 p.m. Meeting 8:00 p.m.—South Bend Division—"Aircraft" meeting. Title to be announced. Speaker to be announced.

Cleveland—Jan. 22

Tudor Arms Hotel; dinner 6:30 p.m. "Liquefied Petroleum Gas as a Fuel for Automotive Equipment"—Leonard Raymond, Socony-Vacuum. "The Propane Story" L. J. Fageol and R. F. Lee, Twin Coach.

Colorado—Jan. 9

Meeting 8:00 p.m. "Engines" O. D. Treiber, Consulting Engr., Hercules Motors Corp.

Mid-Michigan—Jan. 22

Owosso City Club; dinner 7:00 p.m. Meeting 8:30 p.m. "Body Design—Effect of Styling on Drivers" K. E. Coppock, Dir., Exper. & Dev. Sec. G.M.C., Fisher Body Div.

"G.M.C. Consumer Research and Old Designs"—**coffee talk**—Howard Gandelot, Engr., G.M.C.

Milwaukee—Feb. 2

Milwaukee Athletic Club; dinner 6:30 p.m. Meeting 7:30 p.m. "Selection of Steels for Economy and Service" H. B. Knowlton, Engrg. Metallurgical and Materials Engr., International Harvester, Co.

New England—Feb. 6

Graduate House M.I.T.; dinner 6:30 p.m. Meeting 6:00 p.m. "Passenger Cars" American vs. European" Harry Stanton, Auto. Editor, Boston Globe. Meeting under direction of Glenn Whitham.

Oregon—Jan. 19

Imperial Hotel; dinner 7:00 p.m. "Diesel Injection Systems" George Ohler, Pres. Automotive Products. Will talk on his trip to Germany visiting Bosch factory.

Philadelphia—Jan. 10

Engineers Club; dinner 6:30 p.m. Meeting 7:45 p.m. "Are You of Executive Caliber?" Chaplin Tyler, Members, Development Dept., E. I. DuPont De Nemours. Student Night.

Pittsburgh—Jan. 23

Webster Hall Hotel; dinner 6:30 p.m. Meeting 8:00 p.m. "Liquefied Petroleum Gas as a Fuel for Automotive Vehicles" Leonard Raymond Socony-Vacuum Oil Co. Fellowship Hour 6:00-6:30.

St. Louis—Jan. 22

Ladies Night. Theatre Party at Community House. Buffet supper.

Southern California—Jan. 18

Rodger Young Auditorium; dinner 6:30 p.m. Meeting 8.00 p.m. "Power Application Determining the Success of Motor Trucks" Harold H. Hall, Serv. Mgr., Cummins Engine Co.

Southern New England—Feb. 13

Hotel Bond Ballroom; dinner. Eugene E. Wilson, former Pres. of Aircraft Industries Association will be speaker.

Twin City—Jan. 10

Curtis Hotel Solarium; dinner 6:30 p.m. Meeting 8.00 p.m. "Development of Gas Turbine Electric Locomotives J. C. Rhoads, Div. Engr., General Electric Co.

Virginia—Jan. 22

William Byrd Hotel; dinner 7 p.m. Meeting 8:00 p.m. "Tire Maintenance" E. C. Fox, Res. Development, Firestone Tire and Rubber Co., Cocktail hour 6:30 to 7:00 p.m. in Westover Room.

Wichita—Jan. 18

Dinner 6:30 p.m. Meeting 8:00 p.m. "Cabin Pressurization Problems" John J. Swearingen, Head of CAA Medical Research, Lab. of Oklahoma City, Okla.

NATIONAL MEETINGS

MEETING	DATE	HOTEL
	1951	
ANNUAL MEETING and Engineering Display	Jan. 8-12	Book-Cadillac, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 6-8	Book-Cadillac, Detroit
AERONAUTIC and AIRCRAFT Engine Display	April 16-18	Statler, New York City
SUMMER	June 3-8	French Lick Springs Hotel, French Lick, Ind.
WEST COAST	Aug. 13-15	Olympic, Seattle, Wash.
TRACTOR	Sept. 11-13	Schroeder, Milwaukee

SAE Section Meetings

Stresses Importance Of Vehicular Safety

• Detroit Section
W. F. Sherman, Field Editor

Nov. 6—Because the movement of people is the greatest characteristic of this age, much more effective effort must be put into the task of safeguarding the well-being of people in vehicles, in the opinion of **Dr. Ross A. McFarland**, associate professor of industrial hygiene, Harvard University.

The next greatest vehicular developments may be in the field encompassed by safety, health, efficiency, and comfort, he predicted.

Accidents are the greatest single cause of death in the age groups of four to forty-five years, therefore there is much reason to concentrate on the safety aspects of vehicle design and operation, McFarland asserted. As to operator ability in handling a vehicle, it is important not only to design seating controls and other details to meet exacting specifications, but human factors and implications of design must be considered. He cited two examples from World War II. Tanks were not designed for comfortable operation in desert temperatures. Consequently tank crews opened hatches and enclosures, and rode with their heads sticking out, even though their exposure to enemy weapons was much greater than it should have been. Another design defect in aircraft cost the loss of hundreds of aircraft due to confusion between controls operating flaps and landing gear.

Research on hearing requirements for aviators indicates that some older and experienced pilots whose hearing is "not so good" hear best in the presence of noise. Similarly, older drivers or operators of vehicles probably develop compensation factors, he said. At the same time age produces some important effects, such as an increase in light or glare sensitivity, possibly 200 to 300% change being noted. Studies of diabetic airline pilots led McFarland to take a strong position against their continuing to fly, but he said that more must be learned about the subject.

The speaker commented on the fact that vehicle operators with high accident records frequently have records with courts, police and social agencies.

Human "sizing" studies were urged by McFarland as a means of determining data on eye level, reach, and so forth. An attempt to satisfy a distribution curve, rather than just a normal or mean, was advocated.

Aviation Advances Create New Problems

• Baltimore Section
G. H. Rice, Jr., Field Editor

Nov. 9—Pointing out that the first half of the Twentieth Century has been unparalleled for its scientific progress, Speaker **C. C. Pearson** noted that it was unfortunate that the "A" and "H" bombs had taken the limelight from such other developments as the turbojet, turboprop, ramjet, pulsejet, rocket power, radio-controlled vehicles, and electronic brains.

Pearson, who is president of Glenn L. Martin Co., said "This era needs the contributions of trained minds. The pressure is on for more and more progress, faster and faster, and the engineer must meet the challenge.

"The rapid advance of science has created a very real shortage of trained personnel. Therefore it is necessary that our engineering education facilities are kept adequate to meet the demands upon them. Young engineers must be encouraged to complete their education so that sufficient continuing effort can be applied to future problems."

A brief resume of the present status of the aircraft industry disclosed some pertinent information about production potentialities in the event of all-out mobilization. There are over 60 plants now engaged in the manufacture of aircraft and parts. They employ 250,000 workers and build 64 models. About half of these models are military.

Total number of planes ordered in fiscal 1951, Pearson said, will exceed 10,000 airplanes, four to five times the number originally planned, at three times the total cost. This will not approach the 1943 peak of 23 billion dollars for aircraft. Thus the present program is far from total mobilization, and can best be accomplished by increasing utilization of present active facilities by greater concentration of men and machines and operation on a shift basis.

Pearson illustrated the entirely new concept of integrated design, which Martin calls "Systems Engineering," by the following example: "Man is designed to move at 3 mph, and react in painfully slow tenths of seconds.

Shown at Baltimore Section's Nov. 9 meeting (l. to r.): William B. Bergen, chief engineer of Glenn L. Martin Co.; Albert S. Polk, Jr., Section vice-chairman, Aviation; Speaker C. C. Pearson; Chairman Raymond T. Long; Vice-Chairman George Coleman; Secretary Richard Ashley; and Treasurer Ward Bennett

When he must move at supersonic speeds and destroy unseen targets in thousandths of a second, he requires mechanical and electronic assistance. In the past year we have recognized that the differences between piloted aircraft and pilotless missiles are becoming less and less distinct, because the automatic devices are taking over more and more of the crew's former functions. This similarity of function required application of the new engineering concept."

Describes Procedures In Dust Tunnel Tests

• New England Section
C. G. MacDermot, Assistant Field Editor

Nov. 14—New England Section members and their guests heard two speakers at this meeting: SAE Past-President **W. S. James**, vice-president of Fram Corp., and Glenn Whitham, who described a recent trip abroad that included a visit to the Paris and London Automobile Shows. He described production conditions in many countries including England, where four to five years is the delivery schedule for one manufacturer's cars.

James reported on dust tunnel experiments Fram is conducting to evaluate relative importance of protective devices for intake air systems, ventilating systems, and oiling systems of automotive engines.

Tests are conducted in a tunnel large enough to house a cruiser bus; vehicles are run at an equivalent road speed of 60 mph at full throttle during tests. Blowers for the dust-laden air absorb power through rolls driven by the rear wheels of the vehicle. A smokemeter measures dust concentration in the air. Cars receive a 7000-8000 mile break-in on the road before being put on test.

James said several methods are used to determine the end point of the tests. Blowby, which is accurately measured throughout the test, should not exceed 8 cu ft per min (it is about 0.5 cu ft at start of tests); development of bearing noises is another criterion used to determine when to stop a test. As an indication of engine condition, oil pressure is measured with the relief valve locked closed, compression pressure is measured each time the air cleaner is changed, and finally the engine is disassembled at intervals and the increase in bearing clearances, ring gaps and cylinder bore taper determined.

James stressed importance of using a filter of the highest possible efficiency; for example, engine wear rate due to dust would be cut in half by the substitution of a filter 99% efficient for one only 98% efficient in removing dust.

Discuss Uses Of Small Engines

• Mid-Continent Section
D. W. Frison, Field Editor

Nov. 9—**W. F. Ford** and **O. L. Spilman**, Continental Oil Co., presented their paper "Small Engines and Dynamometers for Pilot Testing," originally given at the 1950 SAE Fuels & Lubricants Meeting.

The engine from the "Farmall Cub" tractor has been found satisfactory for pilot-testing fuels and lubricants, and assures good correlation with accepted full-scale gasoline engine tests, reported the speakers. They said that the "Cub" has an engine that offers flexibility over a wide range of operating conditions, so that fuels and lubricants may be tested under differing circumstances. The engine permits accurate prediction of the performance of fuels or lubricants in full-scale engines under given conditions, according to the speakers.

Some of the men who helped make the meeting a success were Section Chairman W. K. Randall, Carter Oil Co., D. R. Frey, Deep Rock Oil Corp., H. P. Enders, Anderson-Prichard, Frank De Fore, Ethyl Corp., John Baird, Lubrizol, Virgil Brazier, Petroleum Marketing, and Don Frison, DuPont.

Nuclear Energy Feasible For Aircraft Propulsion

• Dayton Section
Lewis A. Leonard, Field Editor

Nov. 6—Various types of aircraft propulsion—reciprocating engines, turboprop, turbojet, ramjet, pulsejet, rockets, and nuclear energy—were described to this Section by **Lt.-Col. P. F. Nay** during a visit to the powerplant section at Wright-Patterson Air Force Base.

Nay, assistant chief at the powerplant laboratory, explained that reciprocating engines would probably be omitted for propulsion of future aircraft. Although immediate outlook centers on turbines, jets, and rockets for propulsion, he said it has been decided that nuclear energy is entirely feasible for aircraft propulsion.

Turbojets of 10,000 lb thrust are now being designed and tested, while future ramjets and rockets now proposed have considerably larger thrust, declared Nay.

Specific fuel consumption continues to be a major problem with jet and rocket power, he observed. This has recently made the turboprop a favorable combination after it was set aside for about five years.

Present turboprop installations are in excess of 5000 hp, while designs are being tested up to 10,000 hp.

He noted that many of the present turbines have doubled their thrust since they were initially designed.

Afterwards, the Section toured the powerplant laboratories and saw demonstrations of test apparatus and various types of powerplants.

Props Are Good From Economy Standpoint

• Atlanta Group
S. E. Ellerbe, Field Editor

Nov. 20—The work of Frank Whittle on jet aircraft in England was continued in the United States by General Electric with the development of the I-16, probably our first jet, said **Dr. A. Y. Pope**, associate professor of aeronautics at the Georgia Institute of Technology, in his talk "New Jet Aircraft and Related Subjects."

Pope explained that the outstanding advantages of the jet are power and elimination of many obstacles to streamlining of the fuselage. Fuel is injected into many of these engines at 300 psi, which results in four times the power received from a piston engine, but increases fuel consumption as much as eight times. Some new engines burn 6 gal of fuel per mile. The F-80 gets approximately two miles per gal. This high fuel consumption results in short flight range and causes the pilot to spend much time watching fuel gages.

Props are bad aerodynamically speaking, but are very good from an economy standpoint. This results in the use of a combination of jets and props for long range patrol planes, Pope said.

He predicted that coal will be our additional source of fuel in the near future, since 78 gal of 130 grade fuel can now be produced from one ton of coal. When asked about swept-back wing design on jets, he advised that they are only necessary above 600 mph, and are of no particular value at 1000 to 1200 mph, since they interfere with landings. He expects elimination of landing flaps. The ramjet uses the speed of atmospheric air, entering the jet to produce compression. Therefore, it is good only at top speeds.

Pope stated that jet pilots originally had difficulty because of three things: (1) insufficient oxygen; (2) excessive temperatures; and (3) too high acceleration. These difficulties have now been eliminated by use of oxygen, pres-

urized and refrigerated cockpits, and by having the pilot fly the plane in a prone position. Use of the G-suit, which compresses the blood into the pilot's head, enables him to withstand 9 g, whereas a properly strapped-in pilot in prone position can withstand 5 g.

Biggest problem encountered by jet pilots in combat, is difficulty in seeing other planes at high altitudes and speeds. For this reason the B-36, equipped with four jets, is a good bomber, as it can fly at 450 mph at 50,000 ft, Pope concluded.

Self-Shift Transmissions Won't Antiquate Clutches

• Central Illinois Section
Harlow Piper, Field Editor

Nov. 20—Increasing use of automatic transmissions will not atrophy friction devices or clutches, advised **Harold Nutt**, vice-president in charge of engineering, Borg and Beck Division of Borg-Warner Corp. Automatic transmissions in use today need three or more such devices to handle the speed range.

The Chrysler semi-automatic transmission is connected with a fluid coupling through a conventional clutch which is used to shift to neutral, high, or low range. Hydramatic uses two multiple disc friction clutches and two brake bands in addition to a reverse sprag.

Buick's Dynaflow has a multiple disc clutch and two bands. The reverse band must carry 6.34 times engine torque as against 1.84 times engine torque in low range. This condition must be met by all converter transmissions with planetary gears, observed Nutt.

In Packard's Ultramatic transmission, a direct drive clutch ahead of the converter takes over after acceleration needs have been met. There is also a multiple disc clutch and two bands—one for low range and the other for reverse. The Studebaker drive resembles Ultramatic, but has one more brake band and gear ratio.

Chevrolet's Power Glide has a multiple disc clutch and two brake bands. It is quite similar to Dynaflow. Ford uses two multiple disc clutches and two brake bands so that the driver has control of transmission ratios.

In his talk "Clutches, Now and Tomorrow," Nutt also showed how developments in single plate clutches made possible easier clutch adjustment, lower cost, reduced space, lower friction in the lever system, elimination of free play of the plates, and vibration dampening.

Oil Viscosity Meter Demonstrated By Randall

• Kansas City Section
R. W. Laing, Field Editor

Nov. 14—The consumer today is being supplied by the petroleum industry with various types of additive oils which can meet most any usage without producing undue adverse conditions such as normally result from the use of a regular type of oil, explained **Clark C. Randall**, staff engineer of Sinclair Refining Co.

Additive type oils contain oxidation inhibitors and detergent-dispersant additives to prevent formation of sludges and lacquers, and corrosion of bearings in modern high output engines. They also contain foam inhibitors to insure uninterrupted lubrication of all moving parts. Amount of additives used depends upon engine requirements to be met, and resulting specifications for the oil.

Using special equipment and test apparatus, Randall demonstrated: (1) difference in the amount of additives for a Premium and a Heavy-Duty type of oil; (2) oil viscosity meter (Viscosimeter), along with a demonstration of a small crankshaft-connecting rod unit, showing the need for different viscosity oils to suit the mechanical clearances in an engine and the speed of the engine; (3) oxidation stability of the Regular and the Heavy-Duty types of oil; (4) effect of detergency-dispersancy inhibitors and their ability to handle oil oxidation products formed in engine operation; and (5) the foam inhibitor . . . showing effect of oil foaming on engine operation and the small amount of anti-foam inhibitor needed to overcome this condition.

It was brought out in a discussion which followed, that: (1) oil type should be selected for the service in which it is to be used . . . milk delivery trucks where a considerable number of starts and stops are required; (2) aircraft engine manufacturers and customers are beginning to look to additive type oils as a means for longer engine life; (3) premium type oils sold at filling stations are normally an additive type of oil; (4) reclaiming of additive type oils is difficult and becomes mainly a problem in economics.

Randall contended that additive type oils in general have been of great benefit to all classes of internal combustion engine services.

Diesel Fuel System Described By Hall

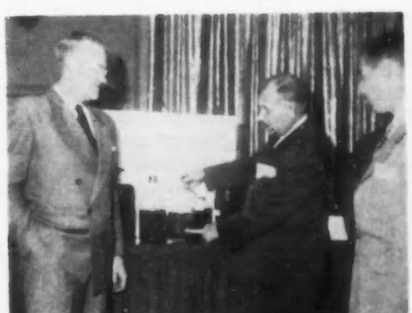
• British Columbia Section
J. B. Tompkins, Field Editor

Nov. 7—Basic principles of the exclusive fuel system pioneered by Cummins Engine Co. have been retained in development of the new DD Fuel Pump, said **Harold Hall**, general service manager, Cummins Engine Co., in a talk about the "Heart of the Diesel—Its Fuel System."

"The number two gear pump delivers the fuel from the float chamber through the suction disc to a single metering plunger. This plunger measures the proper quantity of fuel and delivers it through the discharge discs at the proper times and at low pressure to the injectors," Hall said.

Major difference between the old single disc and the new double disc fuel pumps on Cummins Diesel is that the DD pump has two sets of distributor discs and covers, the speaker explained. Reason for both suction and discharge discs, eliminating necessity for a single disc and cover to perform two jobs, is "to prevent the reversal of

Kansas City Honors Past Chairman, Hears Oil Man Speak



Harold Twyman (left), Bendix Aviation Corp., receiving a framed certificate from Kansas City Section Chairman E. L. Bailey, in recognition of his services as last year's chairman

Speaker Clark C. Randall of Sinclair Refining Co. demonstrating differences in Premium and Heavy-Duty oils to Frank W. Minor of Sinclair (left) and Section Chairman E. L. Bailey (right) at the Nov. 14 meeting

direction of fuel flow in the same passage." Result is better hydraulic characteristics, and reduction in size of the disc and cover, periphery speed, and possibility of disc scoring.

Top features listed by Hall for his organization's new DD included: (1) mechanical governor limiting the maximum and idling rpm; (2) ball and needle bearings to replace bushings, thus reducing frictional loss; (3) reduction of weight, (desirable from the operator's standpoint) smaller physical dimensions resulting in easier maintenance and installation; (4) longer life and reduced maintenance; and (5) higher hp from higher engine speeds.

Sparked by success of its DD fuel pump providing a better fuel system for higher rpm, Cummins investigated the "ever increasing demand for a small lightweight diesel to power trucks in the 45,000-55,000 gvw group," Hall told his audience. "Market research . . . indicated that the design should be a supercharged engine of higher rotative speed. The result . . . was seen in the first production Cummins Model JBS engine in May, 1950."

"The DD fuel pump has enabled us to obtain the desired operating characteristics from this engine at 2500 rpm, which in turn results in the 150 hp necessary for satisfactory operation of this type of vehicle (45,000-55,000 gvw)," Hall claimed.

Tells of Growth Of LP Gas Use

• Washington Section
Louis Reznek, Field Editor

Nov. 21—"Liquefied Petroleum Gas as a Motor Fuel" was discussed at this meeting by **F. E. Selim** of the Philgas Division of Phillips Petroleum Co.

Selim said that in 1949 55% of the petroleum reserves in this country were in the form of natural gas and natural liquids; by 1960, this percentage will rise to 72. At present, liquefied petroleum gas, when converted to a gallonage basis, is being used at the rate of 15 gal to 100 gal of motor fuel; by 1960 this is expected to rise to 40 gal to 100. Additional charts indicated that not only does the gaseous fuel supply exceed any foreseeable future demand, but there is a likelihood of an ever-increasing reliance on the gas reserves as the major fuel source of the future.

As for distribution, he reported that there is a framework of pipelines, bulk-plants, and service stations presently in use which could readily be expanded to meet future needs. Technical problems of distribution and storage have been solved and there has been much experience, particularly on the West Coast, which indicates that no difficulties will arise in that direction.

Although butane has only 92,000 Btu's per gal as compared with 120,000 for gasoline, engines will operate efficiently on butane at 10 to 1 compression ratio. This results in a 17% fuel saving. Fleet and road tests show that because of better carburetion and absence of engine choking, approximately the same number of miles per gallon will be obtained with either type fuel. The price differential averages about 6¢ per gal, so that fuel cost saving is evident. Selim also reported that maintenance costs are considerably lower for the gaseous fuel.

Discusses Aluminum For Vehicle Use

• Philadelphia Section
M. A. Hutelmyer, Field Editor

Nov. 10—On his talk, "The Use of Light Weight Material in Transportation Vehicles," **Frank Jardine**, manager of the development division of the Aluminum Co. of America, touched on the following: (1) use of aluminum from an economy and engineering standpoint; (2) possible cost and possible weight saving; (3) units which are being made and used in production today; and (4) some of the new developments which are going forward for the future.

This talk was presented under the direction of B. F. Jones, technical chairman. It was followed by an open discussion.

Tells Ways to Measure Roughness of a Surface

• Milwaukee Section
E. L. Conn, Field Editor

Dec. 1—Because the design engineer now specifies surface finish, practical finish measuring methods and accepted standards must be adopted, urged **Dr. Ernest J. Abbott**, president of Physicists Research Co. Comparative and direct methods can be used to measure roughness, he pointed out in his talk "How Shop Men Measure Finish in Millionths —and Why."

Surface finish encompasses height of roughness, lay or appearance, and spacing or width of roughness, explained Abbott. Roughness applies to projections with less than 1/32-in. spacing, while waviness is considered a condition with spacing greater than that.

Comparative methods of measuring roughness include appearance, finger nail test, replica, Fax-Film impression, air leakage, and photo-cell measurement of reflected light.

Roughness height can be measured directly by one of three instruments: the Profilometer, the Brush Surface Analyzer, or the Taylor, Taylor, and Hobson instrument. The Profilometer is the most widely used.

The Profilometer, Abbott advised, was developed for shop use and is not a laboratory instrument. It gives readings in micro-inches, RMS.

Only by direct measurement can roughness be properly evaluated, demonstrated Abbott. For example, it is possible under certain conditions to get a smoother surface finish with a course grinding wheel than with a fine grit wheel. Shop men have learned it pays to cut a smooth finish on rough as well as finish operations.

More use will be made of the Profilometer to measure carbide tool surfaces for proper operation, predicted the speaker. Tests show it is possible to increase tool life by as much as 100 to 150% by using a Profilometer to check for proper grinding of carbide tools.

The Profilometer is initially calibrated with an oscillating reed and a microscope with a graduated sight glass. The diamond at the exploring tip lasts six to nine months.

Practical Flight Safety Reported as CAA Goal

• Southern California Section
R. Strasser, Field Editor

Nov. 21—The CAA fills an urgent need in aviation by regulating and enforcing flying safety, demonstrated **Richard F. Bache**, chief, Aircraft Engineering Branch, Civil Aeronautics Authority, Sixth Region.

Minimum safety standards would vary considerably were individual manufacturers free to develop their own, Bache declared. In the interest of public safety, it works best for the Federal Government to set up safety standards as legal requirements, in cooperation with manufacturers.

The CAA has three functions in its flight safety job. They are:

1. Establishment of air navigational facilities.
2. Certification of pilots and aircraft, and regulation of air commerce in the interest of safety.
3. Promotion of air commerce.

CAA's basic policy is to permit and encourage manufacturers to advance aircraft design. But it also makes sure that only safe ariplanes are approved.

Bache pointed out that safety some-

…es gets inadequate consideration in …sign because it complicates matters. …here safety and economics lock horns … a design problem, safety often comes …t second best. This further justifies …rveillance by an impartial body in …e interest of maintaining satisfactory …fety standards.

Powerplant fire protection is a case …n point. There are three ways to …uard against engine fires: (1) a means …or shutting off gasoline flow to point …f failure; (2) means of containing or …preventing spread of fire from point of …rigin; and (3) a means of quickly de…tecting and extinguishing fire.

Without more specific requirements, an airplane might be hopelessly weighted down with valves, firewalls, and fire extinguishing agents. This calls for a compromise between the ultimate in safety and practical considerations. It's the kind of problem in which the CAA can help . . . seeing to it that safety is not penalized and that the manufacturer is not burdened with impractical musts.

Tells of Development Behind Product Design

• Southern New England Section

Robert E. Johansson

Dec. 6—The primary target for product designers must be increased sales for their clients. Furthermore, a truly successful achievement of this goal must be made with a product which stands on its own merit without the "propping" of extensive advertising campaigns. With these opening remarks, **Clare Hodgman,** director of product design for Raymond Loewy Associates, addressed members of this Section and their guests on "Product Design."

Hodgman envisioned the product designer as a diplomat who could deal with others; as a realist who knew the client's products and its limitations; and last but not least, as a creator. In this manner, the designer is fully capable of working as a team with the engineering and sales forces he contacts.

The speaker described the many steps which make up the process of developing a client's desire for increased sales into a tangible result. This process includes, in part, initial conferences, rough sketches and comparisons, more abstract sketches, models, accurate drawings, and consultations. Each step is of equal importance to all others, and experience has proven all steps are important for a satisfactory end result.

In conjunction with his remarks, Hodgman presented an extensive col-

Continued on Page 98

25 Years Ago

Facts and Opinions from SAE Journal of January, 1926

Donald Douglas, President, Douglas Co. made this prediction about commercial aviation's future to the Southern California Section:

"Every sober consideration indicates that, even granting the best expectations from the public in the matter of patronage, only strongly financed commercial airplane companies can weather this next period of exploitation. Shoestring days are over. If commercial aviation in its present phase of large operation fails, the dark days to follow will be darker and longer than any aviation has yet experienced."

■

Dies for hot stampings are made of semi-steel castings with their faces built up of a number of 'pick up' forms about 1 in. thick, G. F. Keyes, Mullins Body Corp., said at the Production Meeting. These pick up forms, he said, are made of lead hardened with antimony, which are cast in molds made from wood or plaster-of-paris models. From three to seven 'breaking-down' operations are usually required to produce the finished stamping without wrinkles, buckles, or other defects.

■

The Society's Research Sub-Committee on Headlighting met Dec. 8 for a general discussion of the headlight problem. Present were guests representing car and lamp manufacturers and State authorities. The ramifications of the problem are such that cooperation between these groups seems imperative. . . . Driving at night is still very unsatisfactory because of imperfect illumination.

■

About 15% of those getting the Society's "Positions Available Bulletin" last year were located by the Employment Service. During the year, the Service was used by nearly 1000 members. (Ed. note: see p. 22 of this January, 1951 issue for report on 1950 Placement Service activity.)

■

"The trolley lines of the Capitol District of New York operate at a cost of 50 to 55¢ per car-mile, including all fixed charges. **The 29-passenger motorcoach in the same territory operates at a cost of between 27 and 29¢ per vehicle-mile."—E. A. Murphy, United Traction Co., Albany at Buffalo Section.**

■

Many facts about the new General Motors Proving Ground appear in a paper by O. T. Kreusser, director: Acreage is 1125. The speed track is 20 ft wide and nearly 4 miles long. Traffic is in one direction—clockwise. A concrete under-water roadway is 200 ft long with 100 ft of level section 12 ft wide equipped with parapets to permit flooding to a depth as great as 2 ft.

■

E. S. ("Ned") Jordan, president, Jordan Motor Car Co., is the chief speaker, and C. F. Kettering is the toastmaster for the SAE Annual Dinner at New York's Hotel Astor on Jan. 14.

■

The SAE Storage-Battery Instructions, adopted in 1913, are being cancelled as being no longer in accord with current practice. Originally a basis for battery information in passenger car instruction books, it is felt the Instructions no longer serve any useful purpose.

■

An SAE Student Group has been approved at Ohio State University. Faculty advisors are John Younger, C. A. Norman, and H. M. Jacklin. Chairman is C. W. Smith.

■

The SAE financial statement as of October 31, 1925 showed a net balance of assets over liabilities of $162,467, this being $4221 more than on the same day in 1924.

■

Profit-making uses of airplanes now include, in addition to passenger and freight carrying: advertising, aerial photography, forestry work, crop protection, and mosquito control.—Charles G. Peterson, Wright Aeronautical Corp.

SAE AT

DETROIT INSTITUTE

Prof. L. L. Henry, adviser to the Detroit Institute SAE Branch, shown in the classroom demonstrating the transmission. Henry is assistant dean and professor of mechanical engineering

DETROIT Institute of Technology is located near the center of Detroit's business section. But what the SAE Student Branch lacks in campus life it makes up in the abundance of first class technical speakers and industrial plants available for conducted tours. Detroit companies also make available technical movies covering almost any subject in which Branch members might be interested.

In addition to an already active program of meetings and plant tours, Detroit Tech members last year inaugurated a "coffee and doughnut hour" that has been eminently successful. One of these monthly meetings featured a talk by Watson Ford, chief field engineer for U. S. Rubber Co., who spoke on "The History and Development of the Rubber Tire," and held a question and answer period at the close. Two weeks later the Student Branch made a tour through the company plant, and got a visual picture to add to their word picture of how tires are produced. They have learned a lot about a number of other important engineering subjects in the same complete way since.

Programs are carefully planned with the benefit of the whole group in mind.

One of the regular "coffee hour" meetings. This one followed a talk by H. F. Barr, (circle), chief engineer for the General Motors tank plant at Cleveland

Valuable help is given by Faculty Adviser Prof. L. L. Henry, who contributes freely of his time and experience to help students plan and carry out their programs.

SAE activities at Detroit Institute of Technology began in 1931, when an invitation was extended to DIT's College of Engineering to appoint a faculty representative to the Student Activities Committee of SAE Detroit Section.

As a result of the invitation, which came from Student Activities Chairman Alex Taub and Section Chairman Harry T. Woolson, DIT enrolled engineering students organized an SAE club. From 1931 until 1946 they held an average membership of 35 students. In November of that year they applied for active Student Branch status and received their charter in 1946 at a luncheon in the H. H. Rackham Educational Memorial from Paul Huber, then vice-chairman for Junior Student Activity of SAE Detroit Section.

From that time, the Branch's membership and activities have increased

until it has become one of the largest and most vigorous such groups in Michigan. Student members publish their own paper, a semi-monthly containing news of past and future meetings as well as interviews with prominent engineers.

The Branch has set its sights at a membership of 50 DIT students; during the past 10 years, however, it has reached as high as 100.

Students feel that they derive wide benefits through interchanging plans and activities with Branches in other colleges, through their expanded contacts with the automotive industry, and through the accessibility of SAE publications and SAE services.

SAE Members Who Attended Detroit Institute Include:

Daniel M. Adams (**1941-42**), Alfred Anthony Alessio (**1945-49**), John W. Asselstine (**1944**), Lloyd D. Bevan (**1934-38**), Lawrence G. Boughner (**1929-37**), Harold L. Brock (**1945-49**), H. L. Byerlay (**1925-28**), James R. Cannon (**1938-40**), Frank Anthony Cillette, Roman B. Cuzak.

Ashton A. Calvert (**1938-39**), Willis A. East (**1942-46**), Rollo G. Ellis (**1925-26**), William James Fowler (**1912-16**), Phil E. Haglund, Robert S. Harmount (**1934-38**), William F. Heise (**1938-48**), David Herman Hill (**1945-49**), Robert P. Hoehmer (**1945-48**), Charles F. Hoopes (**1935-38**).

George H. Jobin, Jr., (**1940-50**), R. Boyd Jones (**1946-47**), John J. Jurasek (**1938-42**), Abraham Karapetian (**1943-49**), Alexander J. Kosidio (**1946-50**), Blair S. Kratzer (**1945-48**), Charles T. Langley (**1935-41**), James A. Line (**1933-37**), Howard William Ludwig (**1930-32**), Jess Marosi (**1940-43**).

John C. McLaughlin (**1938-39**), N. P. Miller (**1934-38**), B. John Mitchell (**1934-40**), William Thomas Morden (**1939-49**), L. C. Nyman, Carl A. Nystrom (**1937-43**), H. Richard O'Hara (**1942-43**), John Joseph Olis, Ed. Packer (**1930-31**), W. A. Parrish (**1903-47**).

John A. Patterson (**1939-48**), J. A. Petho (**1924-27**), Harold E. Reed (**1932-34**), Robert W. Renwick (**1939-43**), Albert J. Rhodes, Richard John Scanlon, Jr., (**1946-47**), William M. Shipitalo (**1941-44**), Versile H. Stewart (**1932-36**), C. K. Taylor (**1936-39**), Garthwood R. Taylor (**1938-41**).

Rene M. Van Ee (**1940-49**), John F. Verkerke (**1938-39**), Frederick L. Young (**1942-49**), F. C. Young (**1916-19**), Edmund J. Zeglen (**1937-41**), Walter Ronald Zojac (**1935-39**).

Students Enter Industry

Continued from Page 78

Department of Public Works, Poughkeepsie, N. Y.

A. DUANE CORN (Purdue University '49) to The Pierce Governor Co., Inc., Anderson, Ind.

ROBERT J. MYER (Parks College '50) to Aviation Service Co., Inc., Hartford, Conn.

JAMES S. MYATT, JR. (University of California '50) to Wm. R. Whittaker Co., Ltd., Los Angeles, Calif.

HOWARD M. WHITFIELD (Parks College '50) to Consolidated Vultee Aircraft Corp., Calif.

ALBERT W. PRICHARD (Tri-State College '50) to Union Carbide & Carbon Corp., Tenn.

MIKE RIVILIS (Bradley University '50) to International Harvester Co., Ft. Wayne, Ind.

ROBERT CHARLES HINCK (San Diego State College '50) to San Diego Gas & Electric Co., San Diego, Calif.

ROBERT VERNON COLLINS (Lawrence Institute of Technology '50) to Detroit Edison Co., Detroit.

ALLEN M. BOWER (General Motors Institute '50) to Cadillac Motor Car Division, GMC, Cleveland.

NICK PANTAZE (Academy of Aeronautics '50) to Puggy & Nick's Service Station, Brooklyn, N. Y.

HENRY DAVID CURREY (University of British Columbia '50) to Pest Control, Ltd., Vancouver, B.C.

ROBERT B. JOHNSON (Parks College of Aeronautical Technology '50) to D. W. Winkelman Co. Inc., Syracuse, N. Y.

MAX A. CONVIS (Michigan State College '49) to Duo-Therm Division of the Motor Wheel Corp., Lansing, Mich.

GEORGE W. COOMBES, JR., (University of Southern California '50) to Union Oil Co. of California, Los Angeles, Calif.

EARL H. MOHNSEN (California Aeronautical Technical Institute) to William R. Whitaker Co., Ltd., Los Angeles, Calif.

ERNEST W. MEASE (Lehigh University '50) to Haughton Elevator Co., Toledo, Ohio.

JOHN T. CAMPBELL (Detroit Institute of Technology '50) to Standard Oil Co. (Ind.), Detroit.

Personals

Continued from Page 79

HERBERT OXLEY, who was supervisor of the dynamometer section of Ford Motor Co.'s Engineering Division, is now experimental department manager in the product engineering office of the same company.

WALLACE J. LATCHEM, formerly chief engineer for Thermoset Plastics, Ltd., Dorion, Quebec, is now factory manager in charge of production and engineering for the same company.

JAMES KNOWLES is now chief product engineer in the aircraft engine division of Ford Motor Co. He was formerly resident engineer at Ford's automatic transmission plant.

JOHN E. DAHL has become an engineering laboratory technician with the Scintilla-Magneto Division of Bendix Aviation Corp., Sidney, N. Y. He had been service representative with the same company.

CHARLES F. PORTER, who was chief engineer for Chrysler Corp.'s Airtemp Division, is now a staff engineer, steering, for Chrysler's engineering division.

AUGUST C. ESENWEIN, formerly general manager and executive vice-president of Piper Aircraft Co., is now assistant division manager of the Fort Worth Division of Consolidated-Vultee Aircraft Corp.

A. R. CROFT has left his position as industrial engineer with Electro-Hydraulics, Ltd., to become engineer in charge of design and development with Motor Rail, Ltd., Bedford, England.

ROBERT A. VOGELEI is now a layout draftsman at the Cleveland Tank Plant of Cadillac Motor Car Division, GMC. He had held the same position at Cadillac's Detroit Plant.

ERNEST L. RUSSELL, who had been a project engineer, research, with Perfect Circle Corp., is now a tool engineer in the piston ring department, metal products division of Koppers Co., Inc., Baltimore.

JOSEPH R. SHEWITZ is now journeyman aircraft electrician with the Alameda Naval Air Station, Alameda, Calif. Prior to this, he was general aircraft assembler and electrician with Consolidated Vultee Aircraft Corp., Fort Worth, Texas. His new position entails repairing, testing and inspecting electrical systems on naval aircraft in the emergency repair hangar.

DR. GUSTAV EGLOFF, Universal Oil Products Co., Chicago, Ill., has been elected by the University of Edinburgh's Senatus Academicus to give the biennial "Romanes Lecture in Chemistry for 1951." Dr. Egloff, who is vice-president of the Third World Petroleum Congress, will attend the Third Congress, in The Hague, May 28 to June 6, 1951, at which time he will lecture on "Polymerization of Olefinic Hydrocarbons."

DONALD H. DECHANT, formerly an engineer with Waukesha Motor Co., Waukesha, Wis., now holds a similar position with McCulloch Motors Corp., Los Angeles, Calif.

EDWIN J. BURNELL is now chief mechanical production engineer with Hughes Aircraft Co., Culver City, Calif. Prior to this, he was production project engineer with Fairchild Guided Missile Division, Farmingdale, N. Y. In his new position he is in charge of engineering of all missile mechanical components for all high volume productions.

R. A. EDWARDS, previously project engineer with the Gabriel Co., Cleveland, Ohio, is now assistant project engineer with Wright Aeronautical Corp., Wood-Ridge, N. J.

BRITT M. SMITH is now a designer in mechanical development for Boeing Airplane Co., Seattle. He had been a consulting engineer for Engineering Clinic. He was SAE Oregon Section's vice-chairman for aviation in 1949–50.

FRANK P. WATSON, formerly a mechanical design draftsman with Baldwin Locomotive Works, is now a layout draftsman (mechanical) for Piasecki Helicopter Corp., Morton, Pa.

SAMUEL H. WOODS, who had been an automotive engineer with the Ordnance Corps, automotive division, development and proof services, Aberdeen Proving Ground, Md., is now an engineering consultant for the same organization.

CLIFFORD SKLAREK, formerly president of Lorraine Spotlight Corp., is now president of the Skylark Automotive Corp., Los Angeles. He also designs and engineers Skylark products.

3000
2500
2000
1500
1000
500
0
POUNDS
Loads Shown Are Approximate
at 200 4" S P M
Cam Type Shock Absorbers Using 10" Arm
1½" Parallel Cylinder
1½" Opposed Cylinder
1" Direct Acting
1⅜" Direct Acting
1¾" Opposed Cylinder
2¼" Opposed Cylinder
1¾" Direct Acting
2" Direct Acting
2½" Direct Acting
Passenger Cars
Light Trucks and Busses
Heavy Trucks and Busses

Continued from Page 81

Moderate Heat Resistant 13Cr—2Ni—3W

• AMS 5628A, Steel, Corrosion Resistant 16Cr—2Ni (SAE 51431)

• AMS 5642B, Steel, Corrosion and Heat Resistant 18Cr—11Ni—(Cb + Ta) Free Machining

• AMS 5646B, Steel, Corrosion and Heat Resistant 18Cr—11Ni—(Cb + Ta) (SAE 30347)

• AMS 6281A, Steel Tubing, Seamless (Mechanical), 0.55Ni — 0.5Cr — 0.2Mo (0.27-0.33C) (SAE 8630)

• AMS 6282B, Steel Tubing, Seamless (Mechanical), 0.56Ni — 0.5Cr — 0.25Mo (0.33-0.38C) (SAE 8735)

• AMS 6320C, Steel, 0.55Ni—0.5Cr—0.25Mo (0.33-0.38C), (SAE 8735)

• AMS 6322C, Steel, 0.55Ni—0.5Cr—0.25Mo (0.38-0.43C) (SAE 8740)

• AMS 6328A, Steel, 0.55Ni—0.5Cr—0.25Mo (0.48-0.53C) (SAE 8750)

• AMS 6355D, Steel Sheet and Strip, 0.55Ni — 0.5Cr — 0.2Mo (0.27-0.33C) (SAE 8630)

• AMS 6359A, Steel Sheet and Strip, 1.8Ni — 0.8Cr — 0.25Mo (0.38-0.43C) (SAE 4340)

• AMS 6360, Steel Tubing, Seamless, — 0.95Cr — 0.20Mo (0.27-0.33C) (SAE 4130)

· AMS 6365C, Steel Tubing, Seamless 0.95Cr—0.2Mo (0.35-0.38C) (4135)

· AMS 6372B, Steel Tubing, Seamless (Mechanical) — 0.95Cr — 0.2Mo (0.33-0.38C) (SAE 4135)

· AMS 6382C, Steel — 0.95Cr — 0.2Mo (0.38-0.43C) (SAE 4140)

· AMS 6412C, Steel — 1.8Ni — 0.8Cr —0.25Mo (0.35-0.40C) (4337)

· AMS 6413B, Steel Tubing—Seamless (Mechanical) — 1.8Ni — 0.8Cr— 0.25Mo (0.35-0.40C) (4337)

· AMS 6440C, Steel — 1.45Cr (0.95-1.10C) (SAE 52100)

· AMS 6441B, Steel Tubing, Seamless (Mechanical) — 1.45Cr (0.95-1.10C) (SAE 52100)

· AMS 6442A, Steel, 0.5Cr (0.95-1.10C) (SAE 50100)

· AMS 6455B, Steel Sheet and Strip, 0.95Cr—0.14V (O.48-0.53C) (SAE 5150)

· AMS 6530C, Steel Tubing (Seamless) — 0.55Ni — 0.5Cr — 0.2Mo (0.27-0.33C) (SAE 8630)

· AMS 6535C, Steel Tubing, Seamless —0.55Ni—0.5Cr—0.25Mo (0.33-0.38C) (SAE 8735)

· AMS 6550C, Steel Tubing (Welded) — 0.55Ni — 0.5Cr — 0.2Mo (0.27-0.33C) (SAE 8630)

· AMS 7222A, Rivets, Steel, Corrosion and Heat Resistant, 18Cr — 11Ni — (Co + Ta)

· AMS 7472B, Bolts and Screws, Steel, Corrosion Resistant, Roll Threaded

c. New ones being circulated are:

· AMS 7440, Bolts and Screws, Steel, Corrosion Resistant Heat Treated — Roll Threaded

· AMS 7493, Rings, Flash Welded, Non-Austenitic Corrosion Resistant Steels

· AMS 7496, Rings, Flash Welded, Carbon and Low Alloy Steels

d. Revised ones being circulated are:

· AMS 3002A, Alcohol, Denatured Ethyl

· AMS 3004A, Alcohol Mehyl

· AMS 3006A, Alcohol-Water Mixtures

· AMS 3087B, Compound Insulating and Sealing

· AMS 4701A, Copper Wire, Annealed

· AMS 4710B, Brass Wire, Tinned, Annealed

· AMS 4712A, Brass Wire, Annealed

· AMS 4713A, Brass Wire, Eighth Hard

· AMS 4720B, Phosphor Bronze Wire, 5Sn, Spring

· AMS 4725A, Copper-Beryllium Alloy Wire, Solution Treated

· AMS 4800A, Bearings, Babbitt, Tin Base—4.5Sb—4.5Cu

· AMS 4803A, Zinc Alloy Castings, Die 3.9Al—0.55Mg, As Cast

· AMS 4805B, Bearings, Sintered Metal Powder 89Cu—10Sn—Oil Impregnated

· AMS 4815C, Bearings, Plated Silver Steel Back

· AMS 4817A, Bearings, Cast Silver Steel Back

· AMS 4820B, Bearings, Leaded Copper, 71Cu—28Pb—7Ag, Steel Back

· AMS 4822, Bearings, Leaded Bronze, 72Cu—25Pb—3Sn, Steel Back

· AMS 4824A, Bearings, Babbitt Coated Bronze, Steel Back

AMS 4825B, Bearings, Leaded Bronze, 74Cu—16Pb—10Sn, Steel Back

· AMS 4827B, Bearings, Leaded Bronze, 80Cu—10Pb—10Sn, Steel Back

· AMS 5335A, Steel Castings, Sand, 0.5Cr—0.55Ni—0.2Mo

· AMS 5616B, Steel, Corrosion and Moderate Heat Resistat 12.5Cr—2.0Ni (SAE 51414)

• AMS 5630B, Steel, Corrosion Resistant, 17Cr (0.95-1.20C) (SAE 51440C)
• AMS 5632A, Steel, Corrosion Resistant, 17Cr—0.5 Mo (0.95-1.20C) (SAE 51440F)—Free-Machining
• AMS 5641A, Steel, Corrosion Resistant, 18.5Cr—10Ni Free Machining, Swaging or Hot Upsetting
• AMS 5700, Steel, Corrosion and Heat Resistant, 14Cr—14Ni—2.4W—0.25Mo
• AMS 5705A, Steel, Corrosion and Heat Resistant, 12.8Cr—8.0Ni—2.5Si
• AMS 5770B, Alloy, Corrosion and Heat Resistant, Iron Base — 20Cr — 20Ni — 20Co—4W—4Mo—4 (Cb + Ta), Solution and Precipitation Treated
• AMS 6475A, Steel, Nitriding, 3.5Ni—1.2Cr—.25Mo—1.25Al (0.21-0.26C)

Air Transport Future

Continued from Page 75

in equipment, improved utility and comfort, and better maintenance, all provide an opportunity to achieve the highest possible level of safe operation. (Paper "Air Transportation and What is the Technical Future," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950. It is available in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Advent of Turbine And Jato Affect C.A.R.

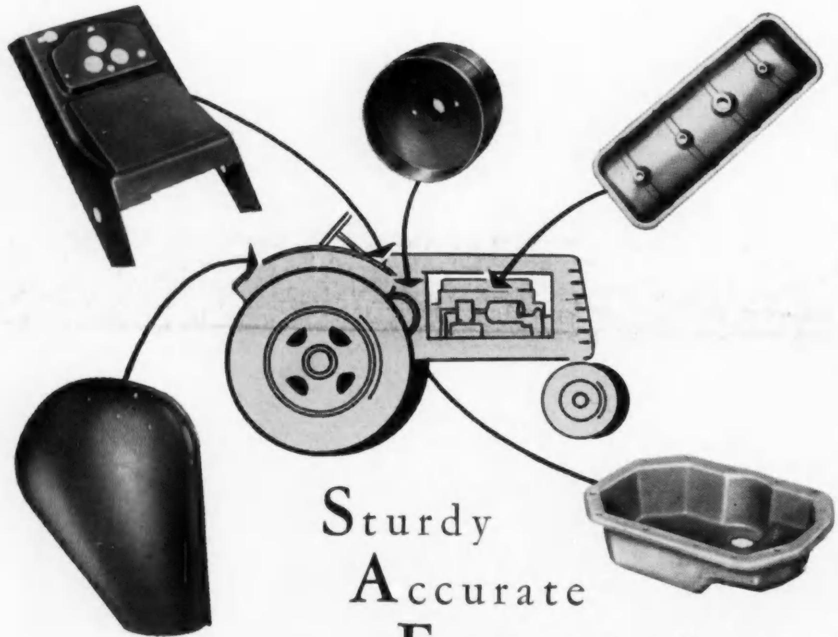
Based on paper by

R. B. MALOY
Civil Aeronautics Administration

THE one-engine-out case is apparently dominant for reciprocating engined aircraft of up to four engines. With aircraft of more than four engines or with turbines the all engine condition may become more critical. Preliminary examinations indicate that for turboprops the one-engine inoperative field length may be satisfactory for aircraft with four engines or less. For turbojets the day-in-day-out climb-out speed will probably be considerably higher than that used with reciprocating engine aircraft. Therefore, the all-engine take-off distance and flight path may be critical, particularly in areas close to the field where obstacles must be avoided by height rather than by turning.

Until more experience is obtained, it appears desirable to include in the Airplane Flight Manual an all-engine take-off flight path with acceleration provided along such a path to the desired climb-out speed and including the gradient of climb with maximum continuous power.

With approval of jato-equipped planes, a proposed basic policy governing these approvals had to be formulated to cope with the problems involved. The regulations specify that a steady rate of climb for a particular configuration be available with certain engine power. This power, even for the take-off rating, can be maintained for a considerable time. Jato units, on the other hand, are of short duration but have thrust enough to enable gaining



height rapidly for a short period. This period with jato, when averaged over a minute, results in an average rate of climb comparable to that obtained with conventional engine power alone. Consequently, the use of jato not only fulfills the intent of the regulation but also would last sufficient time to enable changing to a more favorable configuration, or to circle the airport for a landing.

This paper also discusses changes in C.A.R. since 1940 and the trend away from arbitrary performance standards toward the more rational. (Paper "Safety in Performance Operating Rules," was presented at SAE National Aeronautic Meeting, Los Angeles, Sept. 28, 1950. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to non-members.)

Section News

Continued from Page 87

lection of slides depicting the many facets of product design. Scenes of actual case histories were shown to demonstrate the artistic as well as the scientific approaches to many now famous designs of the Loewy organization.

Gilmoure N. Cole, chief, engine design, Pratt & Whitney Aircraft, was technical chairman for the evening and conducted a lively question period following the talk.

Laughs Predominate At Ladies Night Affair

• Western Michigan Section

L. W. Kibbey, Field Editor

Nov. 21—This Section's annual Ladies Night featured an amateur show in which SAE members and their families participated. Program Chairman Gaylord Smith acted as combination master of ceremonies and magician. The five acts presented included a barbershop quartette, blues singer, semi-classical singer and instrumentalist. Informality of the affair was demonstrated forcibly by singling out all those who appeared in normal attire during the grand march and fining each one dollar.

Tin Rotors, Ramjet Power Cited as 'Copter Advances

• St. Louis Section

C. R. Feiler, Field Editor

Nov. 14—The twin-rotor helicopter offers three advantages while ramjet power promises an eight-way gain, according to **Charles R. Wood**, manager of helicopter contracts, McDonnell Aircraft Corp.

Wood explained that McDonnell selected the twin rotor, side-by-side configuration for the large helicopter because:

1. Span effect of the side-by-side rotors cuts induced power required by about one-third.

2. Fixed wing effect of the lifting pylons supporting the rotors unloads the rotors, delays blade stall, and increase V_{max}. The pylons carry about 25% of the normal gross weight.

3. Better stability and controlability result.

Helicopter rotors powered by ram-

jets are attractive because:

1. No engine warm-up is required.

2. Since no torque is transmitted to the fuselage, there is no need for a tail rotor or other torque compensation. This saves weight and permits aerodynamic refinement.

3. Elimination of supplementary engine, transmission, or complex gear box further saves weight.

4. It increases useful load.

5. Initial cost of the helicopter is lower and short haul transportation more economical.

6. The powerplant is insensitive to quality of fuel, ranging from standard automotive gasoline to 100 octane aviation gasoline.

7. When available in quantity production, the ramjet helicopter will cost little compared to conventional helicopters.

8. It requires much less maintenance.

Wood visualizes the jet helicopter as a potential aircraft for the masses—an "aerial fliver."

Examine New Types of Automatic Transmissions

• Mohawk-Hudson Group

Frank Baker, Field Editor

Nov. 15—"Automotive Transmissions" were examined and discussed at this meeting by **Prof. Louis L. Otto** of Cornell University, who showed a series of slides to illustrate his detailed explanation of the various types of current automatic transmissions.

Otto first reviewed the functions of both clutch and transmission, and the general history and development of each. A lively question and answer forum followed the discussion.

Describes Developments In Waukesha Engines

• Salt Lake City Section

Hal LaBelle, Field Editor

Nov. 27—Highlight of this meeting was a talk by **L. L. Bower**, chief engineer of Waukesha Engine Co., who discussed diesel, gasoline, and propane engines.

Engine development at Waukesha, he said, has been in the direction of large-bore, short-stroke models. They have designed their engines to obtain the most efficient fuel spray and air swirl; the efficient burning obtained pays dividends in cleaner exhaust. He stressed the fact that with a good air-fuel swirl pattern a higher combustion ratio can be used with resorting to as high an octane fuel as would otherwise be required.

Propane is finding increasing use in internal combustion engines, Bower said, because of the fuel surplus and the lower price compared to gasoline.

Tells How Rotation Improves Valve Life

• Cincinnati Section

Walter Walkenhorst, Jr., Field Editor

Nov. 20—Over the past 25 years increasingly severe demands have been imposed on commercial vehicle and farm tractor engines. These demands were outlined by **Herbert C. Sumner**, research engineer of Ethyl Corp., for 160 members present at this meeting.

Sumner told how some of these challenges have been met by the cooperative efforts of the automotive and petroleum industries. Outstanding among results of these efforts has been the idea of using valve rotation to improve valve life. Some factors con-

tributing to great increases in valve life are:

1. Less seat sinkage;
2. Reduction of deposits of accumulation of valve stems, seats, and faces;
3. Reduced valve face burning;
4. Reduction of effects of high temperature leakage caused by valve seat distortion;
5. Reduction of "hot spots" in the valve head;
6. Reduction of stem and guide-wear.

With the resulting reduction in maintenance cost and time lost in the shop, Sumner said, elimination of intermediate valve reconditioning will be appreciable in these days of high operating and labor costs.

Diesel Automobile Development Described

• Southern New England Section
W. M. Jordan, Assistant Field Editor

Nov. 9—Over 100 members and guests heard **J. C. Miller, Jr.**, manager in charge of research for Cummins Engine Co., tell of the research and development that went into making Cummins' diesel-powered car the world's fastest diesel automobile. Miller told how the car qualified for the 500-mile Indianapolis Race after the company had spent six months in development of the high-speed, high-output, low-weight engine.

SAE Student News

Wayne University

About 50 students were present at the Nov. 7 meeting to hear J. C. Hughes of Ethyl Corp. deliver a slide-illustrated talk on Ethyl's octane number—compression ratio research with the GM test engines.

University of Washington

Tory Atkins of Pacific Car & Foundry Co. spoke to students at the Oct. 30 meeting on automatic transmissions—

starting with a history of planetary geared transmission systems and going through methods used today and how they have overcome difficulties encountered in experiments. Most of the credit for modern improvements, he said, goes to the present existence of superior alloys and new machining ideas.

Atkins used a simple power flow diagram to explain the methods of shifting under torque and the various potential ratios possible with the type of unit commonly found in heavy equipment. Among advantages cited were that this unit overcomes the necessity for the difficult and dangerous practice of heavy equipment, and that it is particularly effective in units such as tread-type tractors where rolling friction makes shifting gears with conventional sliding gear transmissions difficult.

The brisk question period which followed was interrupted only when time ran out.

On Nov. 3, Students joined SAE Washington Section to hear H. H. Hall general service manager of Cummins Engine Co. describe the development of the Cummins high-speed diesel engine.

—K. W. Macdonald

Massachusetts Institute of Technology

At the first meeting of the M.I.T. Student Branch, Prof. C. F. Taylor talked on the basic differences between the Diesel engine and the ignition spark type engine. He showed a motion picture which was taken through thick glass portholes to show the burning in the cylinder, using various types of injecting nozzles.

—John C. Conzett

Lawrence Institute of Technology

Ease of both manufacture and operation were goals aimed for by Packard in developing the Ultramatic automatic transmission, reported Forest McFarland, chief engineer, research division, Packard Motor Car Co., on Nov. 16.

Weight and interchangeability with conventional transmission in present Packard models were chief considerations. Production facilities for manufacturing this drive totalled seven to eight million dollars.

A wide range of temperature and altitude conditions were simulated in testing the unit to insure efficient operation under extreme conditions. Cold-room tests showed transition from one gear position to another to be satisfactory even at as low as 0 F.

McFarland acknowledged the participation of W. S. Bopp, a Lawrence Tech graduate, in planning the Ultramatic production program.

Applications Received

The applications for membership received between Nov. 10, 1950 and Dec. 10, 1950 are listed below.

Baltimore Section

William John Sakowich.

Buffalo Section
Albert H. Gille, William H. Millett.

Canadian Section
J. B. Van Der Hout, V. L. Van Der Hout, Charles William Tunis, Richard B. Vesey.

Central Illinois Section
Karl L. Mason.

Chicago Section
V. C. Barth, Kenneth Bruce Bruckelmeyer, Barrett W. Cockrum, Harvey T. Hill, Milton M. Marisic, Ralph C. Ray, Clinton G. Rood, Jr., Robert W. Trueblood.

Cincinnati Section
Robert Thomas Andrew, Frank Richard Flaherty, William Thomas Hammelrath.

Cleveland Section
Joseph E. Adams, Clarence A. Jarosz, Peter Usalis.

Colorado Group
Edward V. Garnett.

Detroit Section
James W. Ames, John J. Armstrong, Louis E. Farkas, Peter Hugh Haller, Thomas L. Heller, John Stephen Holton, Charles J. Koehn, Richard D. Jacobs, II, Kenneth C. Mathers, Malcolm R. McKeller, Floyd C. Melby, Richard E. Rassel, Arthur J. Schuneman, Everett C. Vallin, Arthur M. Waldo, Frank A. Westenkirchner.

Hawaii Section
Jack R. Morris, Bernard S. Ulery, Herbert Won.

Indiana Section
Carl J. Hassett, Carl A. Lindblom, Melvin Joseph Slater.

Kansas City Section
Hal L. Dickerson.

Metropolitan Section
Earl Wilson Ball, Fred H. Bromm, Samuel R. Chasalow, Harald Finnstrand, John R. Flanagan, Paul J. Lederer, Raymond C. Silvers, Louis Steinberg, Lancelot A. Timothy, William Willis, Henry S. Wilson.

Mid-Continent Section
John N. Gromer, R. C. Neely, Robert W. Unterreiner.

Mid-Michigan Group
Robert Bremer.

Milwaukee Section
James L. Gillis, G. Reuter, W. A. Roberts.

New England Section
Alfred E. Anderson, Jr., F. P. Broughton, John H. Durant, Walter J. Good, Richard Y. Grant, Walter J. Holt, Percy Stanwood Ross.

Northern California Section
Arthur R. Chase, Lester E. Lewis, Dave E. Stilleke.

Northwest Section
Howard W. Henry.

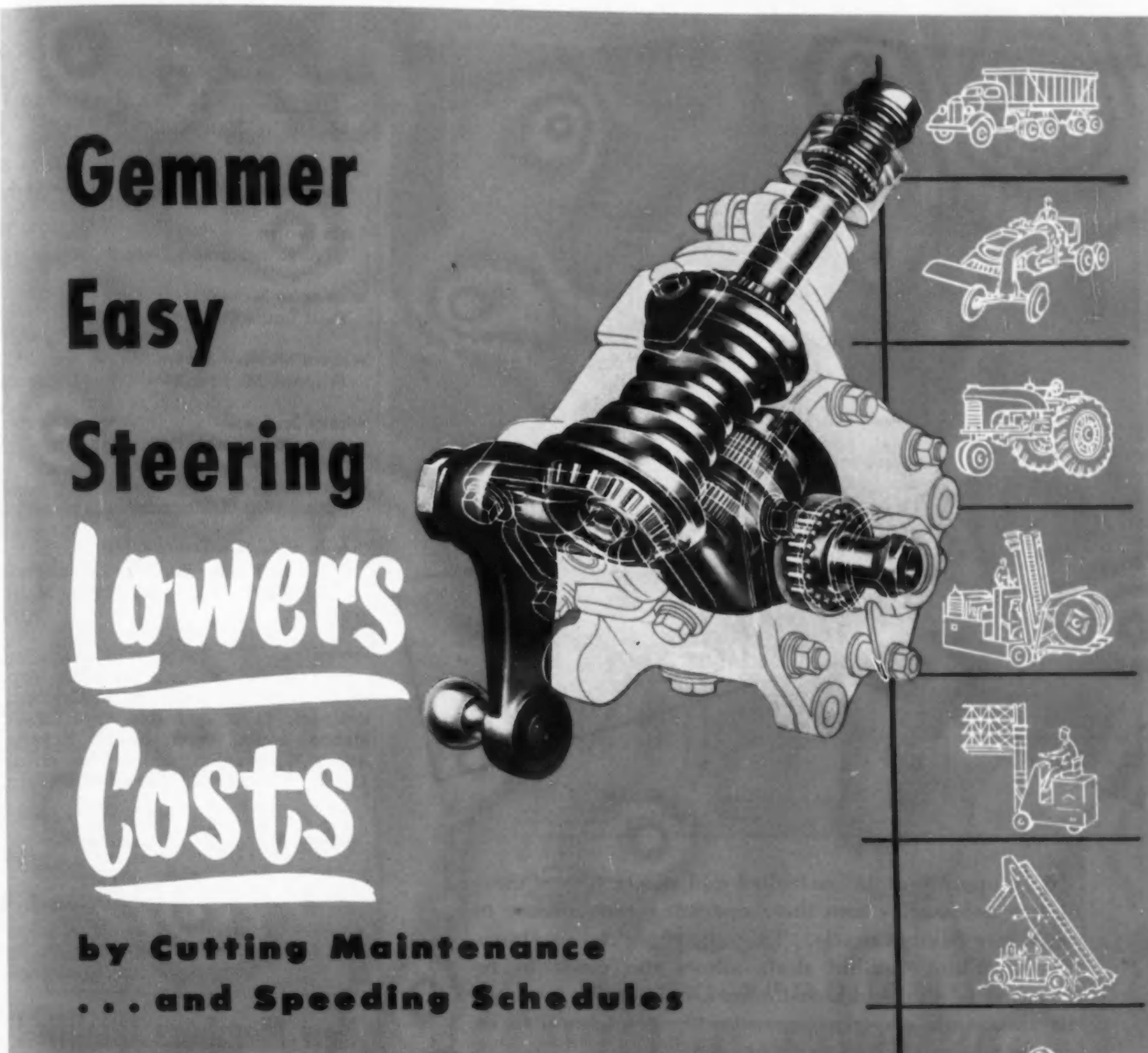
Philadelphia Section
Herbert Barness, George H. S. Snyder, Robert Allen Winemiller.

St. Louis Section
John B. Baker.

Salt Lake Group
James R. Wright.

San Diego Section
Harry F. Bartling, Ben R. Bentson, Delson D. Drake.

Southern California Section
Carlton Reed Chatten, Strother C. MacMinn, Joseph D. Thompson, S. Albert Young.


Gemmer
Easy
Steering
Lowers
Costs
by Cutting Maintenance
. . . and Speeding Schedules
Easy maneuverability of Gemmer steered vehicles helps to make faster schedules through traffic, in and out of parking places, docks and narrow entries. The lessened steering load substantially reduces driver fatigue. No letdown the latter part of the day. Increased mileage per vehicle makes for important reduction in operating as well as capital costs.
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New Members Qualified

These applicants qualified for admission to the Society between Nov. 10, 1950 and Dec. 10, 1950. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

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(M), William C. Rohn (M).

Foreign

Douglas Stuart Ralph Coltart (FM), East Africa; L.A.M.P.L. de Gebert (FM), England; Paul Gomes DePaiva (FM), Brazil; Ladislas Laszlo Gonda (FM), India; E. Grimshaw (FM), Jamaica.

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2. The Secretary or Assistant Secretary of your Section or Group at the addresses listed below:

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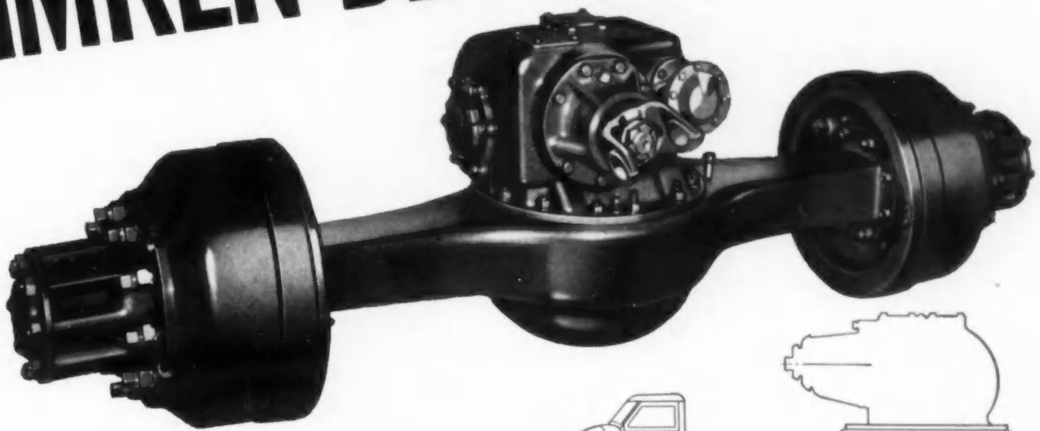

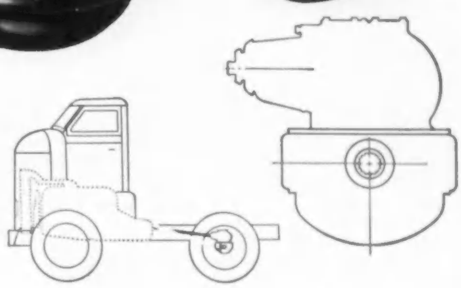

This diagram illustrates how the new location of the pinion shaft makes possible a "straight line" drive through the propeller shaft to the transmission, eliminating angularity problems. A practical length of propeller shaft is possible with a short wheelbase due to the decreased dimension from center line of axle to pinion shaft end.

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For the Sake of Argument

Loyalties

By Norman G. Shidle

Loyalty always gets a hand as an admirable quality. Yet half the woes of the world might be laid at its door. Any given loyalty may seem misguided to you and true to your associates—or vice versa.

"When the Englishman dresses for dinner in the midst of the jungle," Dr. Frank Kingdon wrote recently, "he hasn't the faintest idea he is doing anything extraordinary. If he is surprised about any detail of the occasion, it is that his native bearers are not dressing also. From there his reasoning is simple. The native doesn't dress because he doesn't know it is the only decent thing to do."

Examine the loyalties of any friend. To how many of them do you apply the adjectives mistaken, obstinate, quixotic, stubborn, or blind? List a few of your own, and get some honest friend to apply his adjectives. . . . It is too easy to get agreement on the desirability of being "true to plighted faith or duty"; too hard to agree on what merits plighting.

Loyalties often are the product of enthusiasm rather than of understanding; of self-interest than of human-interest.

Each of us inevitably identifies himself with many ideas, causes, movements, products. Almost all individual activity consists of carrying out the process of being true to some plighted faith or other. That means the broader our individual loyalties, the fewer are chances for clashing with others.

Better understanding of the loyalties of others helps, too, in minimizing clashes. Examination of the other fellow's loyalties often reveals common denominators with your own. . . . Sometimes, of course, understanding works the other way. The more you know of some loyalties the more misguided you will think them. But even that is to the good when based on understanding.

An interesting suggestion for channeling loyalties effectively crossed our desk just the other day. It ran like this:

"Try to increase your respect for the *process* of living and decrease your respect for any special *product* of our society."